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Twentieth Anniversary of Marine Engineering

BY H. L. ALDRICH, PUBLISHER

IN April, 1897, MARINE ENGINEERING made its bow to the shipbuilding and shipowning interests of the country. Evidently this bow made an impression, for among other acknowledgments was one from a fellow publisher who welcomed us in these words: "Another marine publication, known as MARINE ENGINEERING, has made its appearance and we are supposed to welcome it. We do welcome it, just as a passenger who has squeezed his way into a crowded street car welcomes the next passenger who pushes in behind him." It may be said in passing that both the editor who made this acknowledgment and his publication departed from this life some years ago.

The year 1897 held out excellent promises for shipbuilding, as the so-called Spanish War caused an increasing demand for vessels, and during that year, and more especially in the four or five years following, shipbuilders were reasonably busy. Then followed years of dry times, during which the output of American shipyards varied from 636,793 tons in 1901 to 150,866 tons in 1908, reached 506,236 tons in 1912 and dropped to 286,878 tons in 1914. To-day the tonnage under construction exceeds *two millions*

No branch of engineering has been so dependent upon Congressional action as shipbuilding, and never has a journalistic venture had such visions of prosperity held out to it only to have them jerked away, when just within grasp, as has MARINE ENGINEERING. Since 1897, each President of the United States in turn has in vain urged Congress to do something for the promotion and upbuilding of the American merchant marine. Instead of taking such action, it seems to have been the desire of each government in Washington to put some new burden on the operating of vessels, particularly in the foreign trade, but it remained for the present administration to put the strangling grip on the operating of vessels, by placing on the statute books the so-called Seaman's Law. In these war times anything that floats can earn big freight money, but when competition of the seas is again keen, probably no American ship can afford to enter the foreign trade unless the Seaman's Law is radically modified.

Since 1897 many old shipyards have been obliged to give up the struggle and go out of business. Until recently, in all these years, only two or three new concerns have been established. But for the fact that many of the largest yards had facilities for doing work other than shipbuilding, to keep alive, scarcely one of them could possibly have survived the long dry spell.

Among publications in the marine field the mortality record has been even greater than among the shipyards. The shipyards had an excuse for living, but the publications did not.

MARINE ENGINEERING was founded for a real purpose; namely, to give its readers the very best articles that the field afforded and to illustrate them thoroughly. Even in the years when a large proportion of the country's shipbuilding facilities lay idle, we continued to keep our editorial pages up to their highest standard of quality.

So certain were we of the correctness of our foundation plans, that we felt sure of the support of our advertisers. We charged more for a given number of inches of space for twelve insertions a year than any of our contemporaries charged for fifty-two insertions. We thrived in greater proportion than the volume of shipbuilding business warranted, while several of our contemporaries went to the graveyard of purposeless efforts. To-day we have represented in our advertising pages fifteen advertisers whose original contracts date back to 1897, and as many more which date to 1898.

On account of the war, American shipbuilders have been flooded with orders. To-day they are running 100 percent capacity and apparently cannot fail to keep up to this maximum capacity for many years to come. Repairing and replacing the 50,000,000 gross tons of the world's merchant marine existing July, 1914, will require many years of work. Evidently, therefore, investors in shipbuilding plants will at last reap profits from their investments after waiting twenty or more years for them.

During the years 1897 to 1906, shipbuilding in Great Britain was thriving, and yet, with the United Kingdom the greatest shipbuilding nation in the world, there was no publication published there devoted to the interests of the industry that compared in any way, in quality or appearance, with MARINE ENGINEERING. Therefore, in July, 1906, we started an English edition. It was the same as the American edition and published practically simultaneously in London with the American edition in New York. The only difference was in the cover.

The same high purposes which have made MARINE ENGINEERING the one great publication in the marine field will not be varied from in the future. We shall continue to make it the one and only source of information regarding engineering developments in the field. In other words, we shall continue to keep it in a distinct class by itself, as it always has been.

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It is because of this policy that we now have a paid circulation averaging many subscribers per shipyard and reaching most of the steamship and steamboat companies. When the Audit Bureau of Circulations was organized, so as to have a guarantee of truthful circulation statements made by expert accountants, MARINE ENGINEERING was one of the first publications to apply for and to secure membership.

In another respect, the writer feels very proud of the position this publication has taken with its advertisers. Instead of falling into the almost universal custom of publishing anything in the editorial pages that advertisers or others asked for; of paying commissions and discounts and in all sorts of hidden ways charging various advertisers different prices and giving them preferential consideration, we have made the one ironclad rule, to treat every man exactly the same. Every advertiser has the same rate to the cent and is entitled to the same discounts; we pay no commissions nor do we attempt in any other way to "put it over" on any unsuspecting advertiser. In other words, every advertiser in MARINE ENGINEERING is assured of a "square deal."

Progress in Marine Engineering

FIVE years ago, when MARING ENGINEERING commemorated its fifteenth anniversary, attention was called to the rapid progress that had taken place in the development of the science of marine engineering. At that time it was obvious that the period was one of transition and elimination. So many new developments were in the stage of experiment and trial that it was impossible to draw any definite conclusions as to the course which immediate developments would follow. With the increased size of ships and keen commercial competition, economy and efficiency were sought in every possible direction.

Then, as now, the greatest possibilities of securing marked gains in the thermal efficiency of propelling machinery seemed to lie in the perfection of the Diesel type of oil engine. With this goal in view engine builders, especially in Europe, spent vast sums of money in developing this type of machinery. The result was a great variety of designs of both two and four cycle engines. Initial successes in the workshops led to numerous installations—some of comparatively large size—in merchant vessels, but for every successful installation there were scores of failures, due either to defective design or workmanship or faulty installation and operation, and shipowners looked upon the new departure with distrust. At the present time, however, in spite of the serious setback which progress in this line suffered with the outbreak of war, sufficient experience has been gained so that early difficulties have been overcome and several types of Diesel engines are now being adopted with marked success on medium-sized cargo boats. With the return of peace this line of development will undoubtedly receive a new impetus, especially as the reliability of the improved machinery becomes better known.

In the development of steam machinery recent years have brought the successful application of the steam turbine to the propulsion of slow speed cargo boats. This has been accomplished by the adoption of geared turbine units wherein the power developed by highly efficient turbines operating at high speeds is transmitted with practically negligible losses through mechanical gearing to the slow turning propeller shaft. Various arrangements of high and low pressure turbines actuating single or twin screws have been adopted and in some instances the steam has been generated in oil-fired watertube boilers. The economy of such installations has been very marked. Not only has the consumption of fuel been reduced as compared with similar ships driven by reciprocating engines, but savings in the maintenance and upkeep are also possible. With the facilities now available for the production of this type of propelling machinery its widespread adoption in all classes of vessels is assured.

In high speed naval vessels of large power the most notable development of recent years has been the adoption of electric drive. The trial installation of this type of propulsion in a 7,000 horsepower naval collier proved so satisfactory that the navy department has not hesitated to adopt it on all recent battleships and the new battle cruisers. As none of these ships is as yet completed, the result of this policy remains to be determined.

Sea Power

TWO decades ago the United States became involved in a war in which our new navy of armored steel warships was put to its first test. At that time our navy was pitted against a foe whose naval strength and efficiency were far inferior to ours and the result was quickly decided. That brief struggle, however, in spite of the spectacular success achieved by our naval forces, disclosed in no uncertain manner the danger of unpreparedness, the value of naval strength and the lines along which naval efficiency should be sought.

To-day, with the country on the verge of entering the gigantic struggle in which the land and naval forces of the strongest nations in the world have been engaged for over two and one-half years, the first responsibilities will again fall upon our naval forces. How successfully these responsibilities can be borne depends upon how faithfully the efficiency of the navy and the maritime resources of the nation have been developed. Just as the strength and efficiency of a chain are determined by its weakest link, so the efficiency of the navy depends not only upon the strength and fitness of every branch of its intricate organization, but also upon the aid and support which it can derive from the maritime and shipbuilding resources of the country.

Must failure and humiliation be suffered in a great national crisis to teach this nation the folly of its past neglect adequately to foster its maritime resources and develop and maintain a position on the high seas commensurate with its power?

Marine Terminal Engineering

TWENTY years ago, when MARINE ENGINEERING was founded, it would have been impossible for anyone in the United States or in Europe to have written or even conceived such a paper as that given in this issue on "The Terminal Shed and Warehouse."

Some eighteen years ago Dr. Elmer L. Corthell, the late president of the American Society of Civil Engineers, then chief engineer of the Argentine Republic, sent two engineers to visit the principal ports of Europe to ascertain what was the standard practice as to the port development, design and equipment. They returned with the statement that there was no advanced, scientific practice common to many ports, but that each was proceeding according to the individual ideas of its own engineers.

To-day there is a wonderful similarity in plan, equipment, facilities and methods of operation at all foreign

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terminals. The best has survived, and this best for the new American mercantile marine is now being adopted in the new port developments in the United States.

Marine terminal engineering is now as well known as the other branches of engineering and has taken its proper place. As a result, a modern marine terminal is designed along scientific lines, based upon engineering data now available from the world's ports, and combines the best features that have been developed in the leading ports throughout the world.

Open vs. Closed Feed Water Heaters

BY LUTHER D. LOVEKIN*

Notwithstanding the fact that the makers of open feed water heaters have been claiming every advantage over the closed feed water heaters, the question of heat transmission is one that is hardly understood by many of the users of this apparatus. It will be evident to anyone that if a tank is filled with water and exhaust steam led directly into said tank, the entire heat contents of the steam will be absorbed by the water, and the only losses in the open type of heater are, therefore, radiation and loss of vapor. The open heater has the great disadvantage, however, that any oil that may be contained in the exhaust steam mixes with the feed water, and, therefore, requires a thorough filtering. Several types of open heaters are made that thoroughly filter the oil.

Thermal Efficiency

In the closed type of feed water heaters the question of efficiency is one that is hardly understood by most users of feed water heaters, and, in fact, engineers themselves have made many statements which clearly prove a lack of knowledge of the subject of heat transmission. As a matter of fact, the efficiency of a closed feed water heater must be the same as an open feed water heater, providing proper attention is given to insulation and the recovery of the heat from the drains, for the reason that every type of a closed heater must be 100 percent efficient less the amount lost by radiation, if the heat from the drain is recovered by leading the same to a properly insulated feed tank. It can readily be seen that neither heater has any advantage over the other, so far as thermal efficiency is concerned, providing the heaters are properly installed, while the closed heater has the great advantage of not allowing oil in the exhaust to mix with the feed water.

After making numerous tests on different types of feed water heaters and observing results in each particular case, and noting the British thermal unit output to be almost identical under each and every condition, it appears to me that the only question that interests the designer is the ability to design an apparatus with the least amount of surface possible, necessary for a given temperature rise and resistance, and this latter problem forms one of the most interesting subjects in heat transmission.

From numerous experiments made on heat transmission we note that the question of material entering into the construction of a feed water heater is a negligible factor, as the use of copper, brass or iron tubes will show equally good results, for the reason that the heat transmission through various metals is so much higher than it is possible to obtain under actual service in feed water heaters. In a feed water heater the metals having the lowest conductivity are capable of transmitting heat to the water very much in excess of any known rates of heat transmission where steam is used to heat water. This explains the fact as to why an apparatus built with copper tubes has shown no greater transmission rates than an apparatus fitted with iron tubes, and locomotives fitted with copper tubes are good evamples of this very subject.

Very frequently mistakes are made in mentioning the word "efficiency" on account of one apparatus requiring much less surface than another, and while this is really a case of efficiency so far as the ability to design an apparatus with more or less heating surface is concerned, the user of this apparatus will get the same thermal efficiency from the output, no matter what kind of a feed water heater he uses, providing, as before stated, that the radiation losses are reduced to a minimum, the heat from the drains recovered, and the work on the pump is the same. So it can be seen from the above remarks that, so far as the efficiency of the coal pile is concerned, all heaters can be placed on the same basis when properly arranged.

Deciding Factors in Selection of Feed Water Heaters

What is interesting to the user, however, is the purchase price of the apparatus, the cost of pumping the water to the boilers, and, in many cases, space occupied and reduction of weight are important factors, and, in fact, very often the deciding factor in purchasing said apparatus. Another feature which must not be lost sight of is the cost of repairs or renewals. From this it will be apparent that the heater which occupies the least space, has the least weight and the least heating surface, should be the most profitable investment, both initially and for final upkeep, on account of the reduced replacement cost of tubes in the heater having the least surface. This, then, is where the real efficiency counts.

It is well known that many types of apparatus on the market are based on heat transmission rates as low as 200 British thermal units per square foot per degree average temperature difference, while apparatus has been produced that shows more than 1,000 British thermal units per square foot per degree average temperature difference, resulting in designs of feed water heaters having only one-quarter the surface of others and yet being capable of producing the same results. As a matter of fact, heaters have been built which have shown from tests as high at 1,250 British thermal units per square foot per degree average temperature difference, and 1,000 British thermal units per square foot per degree average temperature difference can readily be obtained in practice. It can, therefore, be seen what an interesting subject heat transmission really is, if we can only find time to make the investigations necessary—and surely every effort in this direction is well worth while.

Feed Heater Tubes

Until quite recently it was thought that in order to obtain high efficiency, which meant reduced size of feed water heater, as well as less cost, less weight, etc., it was necessary to use some special form of tube. With a view to ascertaining just what could be accomplished by the use of ⅝-inch condenser tube, I designed and built a feed-water heater and have had extensive tests made of the same under varying conditions which have proven conclusively that there is no object whatsoever in using other than the ⅝-inch condenser tubes (which can be purchased in any part of the world) and which are so easily renewed in case of repairs. In other words, if a feed water heater is properly designed, you can obtain the same temperature rise as can be obtained with any other form of heater under identically the same conditions; the heater will occupy less space, have less weight and less cost of renewals. This is something that the shipowner and the engineer are interested in.

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LETTERS TO THE EDITOR

Development of Oil Tankers

In the comprehensive paper on the earlier stages of tank steamship construction, published in your March number, the one steamer, the construction of which is, and always has been, considered pivotal in the development of tank ships, is not mentioned. This is the German tank steamer *Glueckauf,* built in 1885 by Armstrong, Mitchell & Company, Newcastle, for the German-American Petroleum Company, of Hamburg, after plans of Mr. W. A. Riedemann, founder of this shipping line.

This ship contained all the essentials of modern tank steamship construction up to the time of the introduction of longitudinal framing and the shelter deck. It especially did away with an inner double skin, using the ship's hull as the tank walls. The vessel started on her first trip to New York in July, 1886. Up to 1893 she ran to the satisfaction of her owners, stranding in that year off Fire Island.

The turning out and putting in service of this ship was, however, not accomplished without a number of incidents, which in the light of present-day experience are not without a tinge of humor. In the first place Mr. Riedemann could not find a shipbuilding concern willing to undertake the work. Every one feared to spoil its reputation by a later mishap to the ship. Then English Lloyds, as well as Germanischer Lloyds, refused the classing. This was done by Bureau Veritas, the only society, by the way, which for a long time had any building rules of their own for building tank ships.

On completion of the ship no crew could be obtained for her for some time. After a brief period of service, however, it was found that the dangers emanating from oil vapors were not so unsurmountable as first thought. The shipping people at that time used to refer to this vessel not as to *Glueckauf* (Good Luck), but *Fliegauf* (Fly up), which expectation, however, she did not fulfill.

G. SCHMITT,
Ship and Engine Surveyor to Germanischer Lloyd.
New York.

Reinforced Concrete Ships

The interesting article on the above subject in your January issue prompts me to discuss a few general principles for the benefit of those who refuse to consider the concrete ship as even a remote possibility.

It has been argued that, owing to the alternating nature of the stresses to which a ship's structure is subjected in heavy weather the structural material should be equally adapted, as is steel, to carry tensile or compressive loads. Hence, for equal strength, the reinforced concrete ship would have to have as much steel as the ordinary steel ship, the concrete being valueless in tension, so that the concrete would be just so much extra weight to decrease the carrying capacity of the vessel.

Those who argue as above, however, lose sight of the following facts:

1. The present steel ship does not show an efficient use of the structural materials. Rivet holes, for the attachment of framing to the shell and beams or bulkheads to decks, cut away from 10 to 25 percent of the strength of shell and deck plating. In a reinforced concrete ship it would appear quite feasible to make joints of the steel reinforcement with little or no loss of tensile strength. Furthermore, the steel ship has an excess of strength in certain parts, as a matter of constructional necessity or convenience, but which would not have to be provided in a reinforced concrete ship. In the latter, the bulk of the steel could be placed just where required, thereby effecting great economy in its use without affecting the strength of the structure.

2. The present steel ship must be constructed with a large excess of material to allow for future corrosion and give the vessel a reasonable life. Such excess would be unnecessary with the steel protected from corrosion, as in a reinforced concrete vessel.

The time will doubtless come when, owing to the exhaustion of good iron ore deposits, etc., the price of steel will increase to a point which will force its more economical use and accelerate the development of the concrete ship.

Meanwhile it appears that much remains to be done toward providing a form of concrete which will be suitable for the purpose, a concrete, say, of fibrous structure or containing fibrous material and possessing reasonable elasticity. This done, there would seem nothing ridiculous or chimerical about the idea of large concrete ships, with all their possibilities in the way of rapid and cheap construction.

T. L. E. HAUG,
Alameda, Cal. Union Iron Works Company.

The Most Economical Speed of a Merchant Ship

In the July, 1916, number of MARINE ENGINEERING Mr. Thomas J. Rogers has contributed a very interesting article on "Economic Marine Propulsion." Concerning the merchant ships I cannot, however, agree to the view of Mr. Rogers, nor can I see that the formula calculated really gives the most economical rate possible for such ships.

The formula calculated by Mr. Rogers reads as follows:

$$R = \left[\frac{q}{2k}\right]^{1/3}$$

q being constant expenses in money per 24 hours.
k being the costs of coal in 24 hours at the rate of one revolution per minute.

The formula for R, then, should give the most economical rate possible.

In this formula regard is taken only of the expenses, and the formula postulates that economy will be the best possible when the expenses per revolution are minimized. But this economy is not always of interest to the shipowner, the point being to him that the difference between receipts and expenditures is made the greatest possible. Ordinarily speaking it can very well occur that an increase in working expenses can lead to a yet greater increase of income, the profit then getting a greater one, too.

Considering the conditions of a ship running in a fixed market the amount of freight this ship can earn in a certain period—for instance, one year—will depend upon the number of trips which the ship can run in a year. Assessing the amount of freight earned by each trip on the number of miles passed over, we can say that in this market exists a fixed amount of freight per mile to be earned by this ship.

In a certain period the amount of freight earned will then depend upon the number of miles passed over in this period. On the other hand there will be a multitude of expenses, the amount of which—in a year, for instance—will depend upon the number of trips run in the year. Such expenses are war insurance, freight insurance, harbor charges, etc.

Assessing these expenses for one trip on the number of miles passed over we can in the same way say that in

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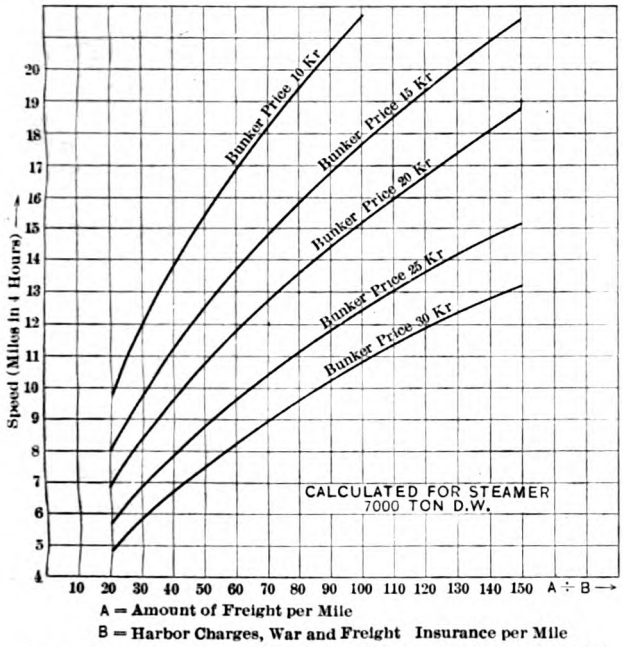
the market exists a fixed expense per mile for this ship and that in a fixed period—for instance, one year—the amount of these expenses will depend upon the number of miles passed over. Besides, we naturally have all constant expenses as hire, etc., the amount of which does not depend upon the number of trips run. The ship, then, must run at such a speed and pass over so many miles per hour that in a fixed period it earns the greatest amount possible of the difference existing in the market between receipts and expenditures.

The profit, however, will not always be the greatest when the ship is running at the highest possible speed, because the speed causes a certain consumption of coal,


Bunker Price 10 Kr
Bunker Price 15 Kr
Bunker Price 20 Kr
Bunker Price 25 Kr
Bunker Price 30 Kr
CALCULATED FOR STEAMER 7000 TON D.W.
Speed (Miles in 4 Hours)
A ÷ B →
A = Amount of Freight per Mile
B = Harbor Charges, War and Freight Insurance per Mile

Curves Showing Most Economical Speed of Steamer of 7,000 Tons D. W.

varying roughly with the cube of the speed. We can now set up the profit earned in 24 hours. The most economical speed will then be the speed making this profit a maximum.

In the calculations the letters have the following meaning:

A = amount of freight assessed per mile,
B = additional dues, as war insurance, freight insurance, harbor charges assessed per mile,
q = constant expenses per 24 hours,
k = cost of coal in 24 hours, the ship running 1 mile per hour,
F = real profit in 24 hours,
S = the number of miles *per hour* making the profit a maximum.

Assuming that the consumption of coal varies with the cube of the speed,

$$F = 24 \times S \times A \div [24 \times S \times B + q + kS^3]$$

If now:

$$\frac{dF}{dS} = 24 \times A \div 24 \times B \div 3\ k\ S^2$$

be placed $= O$. Then

$$S = \sqrt{\frac{8\,(A - B)}{k}}$$

and is the most economical speed possible.

In the formula k can be calculated when we know the consumption of coal at a certain speed of the ship. If the consumption of coal of a ship varies with the speed according to another law than the cube, regard to this is only to be taken in the expression for the consumption and cost of coal. The formula presupposes that the machinery is not forced longer than this law, for the variation of coal consumption with speed really holds good. An eventual increase in the consumption of bunkers will cause a deduction in the deadweight, but in most cases this will have no great influence.

In the figure the formula is calculated for a ship of 7,000 tons deadweight for different bunker prices and the results are set in curves. If $A \div B$, for instance, is 30 and the bunker price is 15 Norwegian kroner, the most economical speed of this ship will be 9.7 miles in four hours.

Bergen, Norway. Francis Konow.

An Unusual Photograph

The accompanying photograph may be of interest to readers of Marine Engineering, as it was taken on board the United States monitor *Tallahassee*, while rounding

On Board the U. S. S. *Tallahassee* During a Recent Storm off Cape Hatteras

Cape Hatteras during a recent storm. As can be seen, heavy seas have complety submerged the forward decks of the vessel, and the picture gives some idea of the severe conditions encountered during the winter months by vessels off the Virginia capes.

L. E. Bordonaro, Electrician (Radio).
U. S. S. *Tallahassee*. U. S. Navy.

Propulsion of Moderate Sized Wooden Cargo Vessels

While the production of a great number of moderate-sized wooden cargo vessels to meet the present emergency is entirely feasible in the United States, the question of powering these ships is likely to present difficulties. There are very few builders of oil engines in sizes of from 200 to 500 horsepower in this country, and it is doubtful if a sufficient number of such engines could readily be obtained. There are, however, a great many manufacturers who are able to supply in a comparatively short time gasoline (petrol) or heavy oil engines of from 100 to 125 horsepower.

If a moderate-sized wooden cargo boat requires 500 horsepower, four engines of 125 horsepower could readily be obtained and arranged to drive a single shaft through reduction gears. With this system, if one of the engines breaks down, there would still remain three-quarters of the total power for driving the ship instead of a complete breakdown, as would be the case with one engine of 500 horsepower. Engineer.

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The Revival of Our Merchant Marine*

Early Development and Subsequent Decline of the American Merchant Marine—The Commercial Crisis Now at Hand

BY GEORGE J. BALDWIN†

WHEN the first settlers reached the shores of New England they found before them forests and a soil not especially bountiful in its gifts to man. It was, therefore, natural for them to earn their living from the sea, and in doing this boats and shipping became necessary; for these the forests furnished the material, so that in those early days almost every man became familiar with the sea and with shipbuilding. He followed the industry from the cutting of the logs in the forest to the placing of them in the vessel by his own labor, for which he was paid by a part ownership in the vessel upon which he afterwards sailed. This produced a race of hardy sailors, skilled in ship construction and operation, intensely interested in their ventures because of personal ownership, which furnished every incentive for the utmost personal effort, and resulted logically in high efficiency.

Thus began the foreign trade of the United States, starting at the fisheries, transporting their products to the West Indies, to Great Britain and the Orient, then bringing back the products of those countries. By 1796 American tonnage was nearly 600,000 tons; 90 percent of our exports were carried in our own ships, and 94 percent of our imports brought back by them, a growth in shipping without a parallel in the history of the world. To preserve this growth we fought in 1812, and became the most successful maritime nation in the world's history. We all remember the history of those dashing clipper ships, the *Rainbow, Flying Cloud, Challenge, Northern Light*, and others, which enabled us to hold supremacy on the ocean highways until shortly before the Civil War.

Loss of American Maritime Supremacy

By this time, however, our people had spread inland. They were engaged in developing the tremendous resources of the country. The production of iron and steel in America was in its infancy, and while our people were gradually withdrawing from the sea, the age of steel and of steam enabled England to take her place upon it. While we could build ships of wood more cheaply than she could, wooden ships were doomed. England's rapidly developing industries in coal and iron enabled her to produce a cheaper cargo carrier than could be built in this country, and from that time until this her supremacy in the ocean trade of the world has been undisputed. This supremacy has permitted the construction of vessels in such large volume that individual shipbuilders have been able to specialize and to construct in large numbers a single type of vessel, bringing their costs lower than those of other nations.

We have learned the same lesson in other lines, notably in the manufacture of machine tools; that is, tools designed for the manufacture of locomotives, boilers, engines and all other kinds of metal work. We now make the cheapest and best machine tools in the world, and this is the foundation of our manufacturing industry. With these tools we have been able to lead the world in producing automobiles, sewing machines, watches and a thousand other specialized manufactures. To-day we owe our manufacturing position to our skill in the design of machine tools, the efficiency of their operation, and the volume of the product we are able to turn out by their use.

Remarkable Success on the Great Lakes

We have had one opportunity of specializing in ships. The traffic on the Great Lakes, protected by law, required that Americans should construct American ships to transport coal, ore and wheat, and because of this protected condition we have been able to produce upon the lakes cargo carriers moving freight at less cost per ton mile than any other agency anywhere else in the world.

No country produces steel, coal, copper and all of the various raw products entering into the manufacture of vessels more cheaply than we do. Our machine shops and technical industries have grown tremendously, our skill to-day in the manufacture of machine tools and other labor-saving machines surpasses that of any other nation, and our inventive capacity ranks equally high. We are generously equipped, ready to begin our struggle for our place upon the ocean. The volume of our foreign trade, already immense, is growing, and will continue to do so. We are becoming more and more a manufacturing nation and must amplify our trade with the newer countries still in the agricultural period of development; and just at this time in our commercial history, when we stand fully prepared to do this, a flood of wealth is accidentally poured into our hands as one of the results of the European war. Our surplus manufactured product is being delivered to these nations, and we are to-day extending credit to them in lieu of the cash they are unable to pay. It is imperative that we find means of transporting our goods in our own vessels, and not in vessels owned and operated by our competitors.

Crisis in American Commercial History

We have arrived at a crisis in our commercial history; if we fail to take advantage of it, the country cannot continue its present progress, but if we grasp it our trade will be immeasurably extended. What better course can we pursue than to devote some of our new capital to the construction of merchant ships, so that we may again carry over 90 percent of our foreign trade in American bottoms? We shall be prepared for any contingency which may befall us, when to this merchant fleet we have added an armed navy capable of protecting it.

The people along our coasts have been more or less awake to this need, but those of the interior have only just begun to think of it. Now, however, the acute scarcity of ocean tonnage and the high costs of ocean transportation consequent upon it have been brought home to everyone, and I believe public opinion is awakening.

England is now engaged in nationalizing her entire shipping for the purpose of using it, not for competition between British subjects, but as a unified instrument directed by one central authority and operated for the benefit of the nation. Can we compete with this unless we are permitted to follow along lines of concentration instead

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* From *The Americas*.

† Senior vice-president of the American International Corporation, president of the Pacific Mail Steamship Company, and chairman of the Board of the New York Shipbuilding Corporation.

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of unlimited competition between ourselves? Japan is taking possession of the trade of the Pacific Ocean. She subsidizes her shipbuilders and her shipping companies, and is to-day in control of the bulk of the traffic on the Pacific. Norway has been concentrating the enormous profits earned by her vessels, and a large proportion of the merchant shipping now under construction in American yards is being built with this money for her benefit.

The cost of ship construction to-day in the United States is no higher than in competing maritime nations, but this is an abnormal condition of which we must take present advantage, and during this period we must learn to construct our ships as cheaply as those of England, Germany, Scandinavia and Japan. To this end our colleges should co-operate. Beginning with the training of our young men during their undergraduate courses, we must coördinate this theoretical education with practical work in our shipyards, so that on graduation our naval architects and marine engineers will be thoroughly qualified for their part in this work. Our shipbuilding corporations must coöperate with the schools and with each other in order that all yards may be able to reduce their cost of construction. To realize the greatest advantage to the nation, our laws should be so modified as to permit the most economical operation of the ships we construct. Our bankers should teach the people the necessity and wisdom of investing in our merchant marine, and finally, the power of the United States Government should be added to our other agencies in order to encourage in the fullest possible manner the growth of our ocean transportation system, so vital to the needs of this country.

If we do these things, our future is assured, but if we fail in one of them we shall lose our opportunity, perhaps never again to secure it.

Shipping to Latin America*

1916's Progress and 1917's Promise — Remarkable Increase in American Ships

BY A. EUGENE BOLLES †

BECAUSE of the difficulty experienced in shipping goods to Latin America during the early part of 1916, many American firms discontinued attempts to secure Latin American business because of the fear that they would be unable to get their goods into the buyers' hands. So many inquiries came to our office for information regarding the shipping situation that we have made this survey in the hope and belief that sufficient facts could be assembled to give satisfactory answers to the questions most frequently asked, viz.:

1. Have shipping facilities to Latin America improved during 1916?
2. Is further improvement promised for 1917?
3. Is a reduction of freight rates likely during 1917?

To secure this information a canvass has been made of every port from Boston to Seattle, every steamship company with lines to Latin American ports, the various Federal departments dealing with such matters, a number of large shippers, the marine periodicals, and several other organizations in more or less close touch with the situation.

WHAT THE PORTS ARE DOING

New York.—A canvass of seventeen steamship companies running on regular schedule to Central and South America and the West Indies brought out in all cases the claim that they were handling all offerings of freight billed to ports regularly reached and that they were ready to increase their tonnage as soon as the demand would warrant it.

Only two companies reported additions to tonnage during the past year, but nine have arranged to restore former service or to add new boats to the number of thirty—one or more during 1917. Of the latter, four freight and passenger boats of 8,000 to 10,000 tons and two smaller boats will be put on about July 1 by Grace & Company, to run direct from New York to West Coast ports via the Canal, making the trip to Callao in eleven days, a saving of seven days over former schedules. Five boats are being built in England for the United Fruit Company, and are to be delivered in the early summer. This company expects to charter several additional boats.

Boston's steamship service to Latin America is practically nil, according to the Boston Chamber of Commerce. There are no direct lines, but many arrivals from Argentina, Uruguay and Chile, practically all of these ships going to New York for return cargo.

Baltimore promises to make for itself an important place on the map as a port of shipping to Latin America. A $15,000,000 (£3,070,000) corporation promoted by local capitalists and fostered by the railroads entering that city, and the city government, will put on a line to South America as soon as equipment can be secured.

Charleston has no direct lines to Latin America, but the Southern Railroad is making of it an important port for coal shipments, a number of cargoes having gone from this port during 1916, and it is expected that the business will materially increase during 1917.

Mobile is planning extensive harbor improvements, and the Munson Line running out of this port to West Indies and River Plata ports has been up to capacity much of the time during the past year, has added two new boats to the Buenos Aires run, and at times has been compelled to put on extra boats from their tramp fleet. It is expected that the River Plata service will be increased to two boats a month during the present year.

The New Orleans Association of Commerce has made a canvass of the nine steamship companies running on regular schedule out of New Orleans to Mexico, Central American and West Indian ports, and reports considerable increase in tonnage during the past year; that all freight is being moved quickly, and that ship owners are prepared to add to the number of boats in service as fast as the demand warrants it.

Galveston.—The Commercial Association reports the re-establishment of one line to Mexican ports during 1916; that they have been handicapped in making further increases because of the scarcity of ships, and that they have

* Read before the National Foreign Trade Council Convention at Pittsburg, January 26, 1916.

† Manager of Spanish edition of *World's Work Magazine*.

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very definite plans for extensive steamer service to West Indies and Central America during 1917.

San Francisco's trade with Latin America during 1916 showed a large increase, according to the Chamber of Commerce, but all shipments were satisfactorily handled.

Seattle's service to Latin America has been materially reduced since the war began, there being at present only two lines running direct, one running monthly and one bi-monthly to West Coast ports.

Lines from South American Ports

In order to provide means for transporting their principal products to market, certain South American republics have by concession, charter, or other methods, aided in the establishment of lines to the United States during 1916. Ecuador, Peru and Brazil have been particularly active in this respect, and it was recently announced that a company with $12,500,000 (£2,560,000) capital had been organized in Chile to establish a line of steamers to the United States.

The Government's Figures

According to Commissioner Chamberlain, of the Bureau of Navigation, ship space available for carrying freight to South America has increased during 1916 50 percent over 1914. The total tonnage of ships cleared during the first ten months of 1914 amounted to 1,700,527 net tons, and during the same months of 1916, 2,516,300 net tons. Foreign tonnage has remained about stationary, the gain being almost wholly in American ships, which in the first period amounted to 171,433 net tons, and in the second period to 914,227 net tons, an increase of 433 percent. The total tonnage of American ships cleared for Argentine during this period of 1916 was nearly thirty times that of the first ten months of 1914; for Chile six times; for Brazil five times; the American tonnage cleared for Venezuela and Colombia doubled, while there were 66,169 net tons cleared for Uruguay against none at all in 1914.

Tonnage of ships for Mexico, Central America and the West Indies increased about 400,000 net tons during the two years, making the total tonnage to all Latin America 7,660,192 in the first ten months of 1914 and 8,840,866 during the same months of 1916.

The total tonnage of ships entered from Latin American ports showed a *decrease* during this period due to the fact that before the war ships from Europe carried cargoes to Latin American ports then proceeded in ballast to the United States, where they loaded cargoes for Europe, and that since the war this triangular trade has largely disappeared. The total decrease in tonnage amounted to 890,624 net tons, but the tonnage of American ships entered from Latin American ports *increased* 3,101,967 net tons, or 154 percent.

There is much in these figures to cheer the heart of the patriotic American who is hoping for the restoration of our merchant marine.

Comparing the first ten months of 1915 with the same months of 1916, an increase of 951,632 net tons clearing for Latin America is shown, of which 933,056 tons were American ships. While the total tonnage of ships entering from Latin America increased 1,098,460, that of American ships increased 1,226,923 net tons, foreign tonnage having decreased about 200,000 net tons.

Two years ago American ships made up 25 percent of the tonnage cleared for Latin America; now the Stars and Stripes wave over 58 percent of it.

Estimates for 1917

The Foreign Trade Department of the National City Bank estimates that the ships to be added to Latin American trade during 1917 will aggregate 300,000 tons. The information assembled to this survey, confirmed by the opinion of several well posted men, seems to indicate that the National City's figure is too conservative, and that the increase will approach close to a half million tons.

Whether the war ends in 1917 or not, there is every indication that a large number of boats other than those already mentioned will be added to Latin American service. Many shipowners engaged in European trade are free to admit that the risk of loss is becoming too great for profit, and well posted men look for the early withdrawal of many ships and their transfer to the safer waters of South American commerce. It is, of course, possible that the recent raid in South American waters may change this opinion to some extent, but it is believed that the shipowners will still prefer to face the few dangers of South American seas rather than the many risks involved in European trade.

On the other hand, the ending of the war will release over 16,000,000 tons of interned or commandeered ships and restore them to the peaceful channels of trade.

The New Shipping Board

The claim has been made repeatedly that the shipowners are awaiting to see what the new Federal Shipping Board is going to do, but persistent questioning has brought out the fact that what the new Board will or will not do is a matter of little interest to shipowners, and the remarkable increase of American ships would seem to confirm this. It is difficult, if not impossible, to find a shipowner in favor of the new law, and there is an increasing sentiment favoring shipping laws modeled after those of Norway, poviding for Federal aid in the form of bond issues guaranteed by the government.

The Question of Rates

Shipowners, like other humans, go where profits promise best. The big demand for bottoms and the excessive rate of insurance has pushed up the European rate and pulled up the rate to Latin America part way. The present rates to South American ports for a run twice as long as across the Atlantic are from 20 to 50 percent lower than the European rates.

Increased competition for South American freight, more boats bidding for business, can have but one perfectly natural result—lower rates. That such a situation is bound to arise in the early part of 1917 seems reasonable to believe, even if not inevitable. Competition for Latin American freight is increasing now and will continue to increase during 1917 by the addition of the half million tons already planned and the indefinite number of boats driven from European trade by the growing danger of destruction; while if the war should end, the release of one-third of the world's tonnage, now commandeered or interned, will naturally reduce the cost of shipping goods to something like a normal figure. The restoration of pre-war rates can hardly be expected, because if hostilities cease in 1917 the world will find itself from 6,000,000 to 10,000,000 tons short of the normal tonnage—about 12 to 15 percent of the total.

Taking the cold facts as they are given in the foregoing, it would seem that only one conclusion is possible, and that is that shippers to Latin America have been through the worst of their troubles, and that they can go full speed ahead with their efforts to become solidly established in the countries to the south with the reasonably safe assurance that by the time those efforts result in orders the goods can be delivered promptly and at a fair cost for shipping.

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Review of the Progress of Marine Engineering During the Last Twenty-Year Period

Conditions in the Marine Field Twenty Years Ago Contrasted with Attainments of To-Day—Noteworthy Accomplishments of American Engineers

BY WILLIAM T. DONNELLY*

WHETHER twenty years or two decades in a human life is a long or a short period of time depends, as in other periods of history, upon the importance of the events transpiring within the period. Considered from this point of view the *twenty years* comprising the history of MARINE ENGINEERING is comparable to as many centuries of time in maritime history only slightly removed from it.

The space allotted to this review of progress during the period referred to is all too brief to convey even an outline of the important advance that has been made in every line of marine endeavor, and if the author shall have any success at all, it will only be by sketching in the background of twenty years ago and then superimposing upon it a picture of our attainments of to-day, leaving the readers to fill in the tremendous gap between, from their own contact and experience.

This will be more readily possible when we take into consideration the fact that most of the men prominent in marine engineering affairs twenty years ago are still with us to-day and taking leading parts, and I feel that there could be no better introduction to the review of this period than reference to a page from MARINE ENGINEERING of November, 1897. From the men mentioned there came the inspiration, encouragement and loyal support which have made an adequate record of the period possible. It would be a presumption to introduce a single one of them, and their names are entered here for record only. All honor to the men who led the way: Clement A. Griscom, W. F. Durand, Irving M. Scott, Lewis Nixon, Commodore Philip Hichborn, Commodore George W. Melville, H. T. Gause, Stevenson Taylor and Edward F. Gaskin.

FIRST HOLLAND SUBMARINE LAUNCHED IN 1897

In May, 1897, there was launched at the yard of Lewis Nixon the first Holland submarine. The success of this boat, together with others designed by John P. Holland, may be said to mark the first successful construction and operation of the submarine. It is worthy of note that at this time submarines were not included in the naval equipment of any of the nations of the world.

In June, 1897, there was given to the world the first account of the application of the steam turbine to marine propulsion, the application being made to an experimental boat, the *Turbinia*, with which a speed of 32.75 knots was obtained. This boat was built purely as an experimental craft by English engineers.

I find that the most notable launching of the year was that of the transatlantic liner *Kaiser Wilhelm der Grosse*, 648 feet in length, displacement 19,684 tons. This vessel broke the transatlantic record with a speed of 21.39 knots.

In 1898 we find the record of the launching of the first Lake submarine, the *Argonaut*, and early in the same year an account of the application of the gasoline (petrol) engine to a small launch. In the description of this boat the term motor boat is applied.

It was perhaps prophetic of the destruction of our own days that in February of this year the battleship *Maine* was destroyed by a mine in Havana Harbor. The Spanish War, which followed closely upon the destruction of the *Maine*, was the first actual test of modern naval vessels constructed in the United States, and the result was such as to add to our loyalty and increase our confidence in our marine designers and constructors, as well as the men behind the guns, not forgetting our equally loyal and efficient commanders.

DEVELOPMENTS IN NAVAL CRAFT

The twenty years' progress in marine arts, as applied to naval craft, has been mainly devoted to the perfection of well-known methods of construction and armament, with the enlargement of guns and a very considerable increase of range due to the advances in the metallurgy of steel, notably in the heat treatment and by the use of certain alloys developed through the use of metals, such as nickel, titanium, vanadium and tungsten, largely increasing the tensile strength and endurance. Perhaps the most marked advance was made in the matter of range finding and fire control, through which not only has the practical range been very much extended but the accuracy and rapidity of fire at all ranges have been vastly increased.

This period has also seen a very considerable modification in the propelling power, with a corresponding advance in cruising and maximum speed. The advent of the steam turbine, together with the ever-increasing size of battleships and cruisers, has made it possible to install power far beyond the wildest dream of twenty years ago, reaching its climax in present designs which contemplate the application of more than 180,000 horsepower to the propulsion of one vessel. The additional boiler power to furnish steam has been obtained largely by the substitution of oil in place of coal for fuel, with a consequent very large reduction in the space and weight required. It is worthy of particular notice that in this extreme application of power the use of electricity for the actual propulsion of warships is being considered for the first time.

HIGH SPEEDS DEVELOPED BY MOTOR BOATS

In December, 1898, the steam yacht *Ellide*, designed by Charles B. Mosher, made a speed record of 40 miles per hour. Both designer and yacht are still with us to-day. While the steam yacht still maintains a prominent place as the luxuriant summer home of Americans of great wealth the application of steam to pleasure craft has been far outshadowed by the development of the motor boat, which is generally understood to mean gasoline (petrol) as a source of power through its use in the internal combustion or gasoline (petrol) engine. By means of this application of power small boats upon the water have finally obtained a speed greater than 60 miles an hour, rivaling the classic express train rate, long considered the acme of all human transportation, and it would almost seem as if the motor boat of comparatively small size and high power was to win the "blue ribbon" of the sea for all

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time by proving itself to be an adequate defense against that terror of the deep, the submarine.

At the beginning of this period wireless telegraphy was unheard of, while now it may be said to outrank in importance all other human means of communication and justly claim to be the most far-reaching and important life-saving device thus far developed in human history.

No phenomena of life make a stronger appeal than the flight of birds through the air and all history records the longing and ambition of man to conquer the atmosphere and join the birds in their flight. For more than four thousand years all the most courageous spirits who dared to attack this problem met only with failure and ridicule. How greatly we should, therefore, honor the men and the period in history that saw its final accomplishment. All praise and everlasting fame to the Wright brothers.

Significance of the Gyroscope

The burning of oil for fuel under marine boilers had hardly been thought of twenty years ago, the use of the Diesel engine for marine propulsion barely attempted, and the application of electricity to the propulsion of vessels was being derided as an economic absurdity. No reference to the accomplishments of this period would be complete without mention of the gyroscopic compass, that modern marvel of scientific accuracy and ingenuity, the one device which bids fair to supersede the lonely mariner's oldest and truest friend, the magnetic compass. The gyroscopic compass may well be described as one of the most important marine inventions over a period of more than three thousand years. It not only guides the mariner with vastly greater accuracy than the magnetic compass, but also serves to direct the submarine below the ocean surface, a task said to be entirely beyond the powers of the magnetic compass. A modified form of the gyroscope has been adapted to control the rolling of ships at sea and its perfection for this purpose may earn for it the title of the best friends of the landsman as well as of the mariner. Another modification has been adapted to control and steady the flying machine and the limit of its possibilities is not yet known. The name of Elmer A. Sperry will be associated with this achievement for all time.

When sufficient time has elapsed to enable future critics to obtain a clear and comprehensive view of this period, it is probable that the relative importance of the many notable discoveries and inventions referred to it will be very much modified. But certainly several of them will hold first place in the long list of important human accomplishments. Within this narrow period, embracing less than the active period of a single lifetime, there have been crowded the discovery and perfection of the means of navigation of the atmosphere surrounding the earth, the means of keeping in constant communication with vessels at sea over all the oceans of the globe, and the perfection of the means of navigation, both for war and for commerce, beneath the surface of the seas. As if to lend final emphasis to this last discovery, it would almost seem as if it was to be the last and final arbiter between the isolated groups of human beings hitherto known as nations, and that it may be *that final invention of man* as outlined by the prophetic imagination of Jules Verne, which was to be so terrible as to make human conflict unbearable for all future time.

Twenty Years of Productivity

No more striking comparison can be made than in the relative importance to this country of marine construction at the beginning and at the end of this period. The opening of the period occurred at a time approximating the most active interior developments of the country, when all the energy and capital and resources of the nation were directed to the construction, development and reorganization of interior communication by means of railways, and for more than half the period under consideration a very small group of men, discouraged and alone, struggled on, laying the foundation and blazing the way for what we are now just beginning to realize as the most intense and crucial period of maritime activity in all human history.

Inland Waterway Transportation

Some reference should be made to the development of commerce and passenger transportation upon our inland waterways, more particularly as the advent of the application of steam power to navigation was commenced upon the waters of our own Hudson River little more than 100 years ago. The development of passenger transportation upon this river has brought into existence within the period referred to the largest and finest-equipped steamers designed solely for the transportation of passengers to be found anywhere in the world. In fact, they are so far in advance that they stand in a class by themselves and are the pride of all who have been privileged to journey on this historic waterway.

Great Lakes Shipping

Equally notable have been the developments on our inland waterways, particularly the system of Great Lakes on our northern boundary. Here we find the commerce and transportation of the great commodities, grain, ore and coal, exceeding that of any other area in the world, and the development of passenger traffic culminating in the Buffalo and Cleveland boats is equaled nowhere else. Many names could be mentioned within the period referred to with reference to this work, none, however, more representative than that of the engineer and designer we all know so well, Frank E. Kirby.

As a final word, this period opened rich in men of vision and genius at a time when the outlook for the future was dark and discouraging, with very little but tradition to be proud of in connection with the maritime situation in America. It closes with America leading the world in activity in all matters of maritime importance, and with the future brighter than the wildest dream ever conceived by the most heroic advocate of the American merchant marine. All honor to the past; all hail to the future!

The First Torpedo Boat Destroyer

Messrs. Yarrow & Company, Ltd., Scotstoun, was the first firm to propose to the British Government the construction of speedy vessels especially designed to counteract the class of torpedo boats then in existence. To the new design was given the name of torpedo boat destroyer.

The first of these was 180 feet long by 18 feet 6 inches beam, and obtained a speed of 26 knots. The second one, which was fitted with Yarrow tubulous boilers, obtained a speed of 27 knots. In 1894 a vessel 10 feet longer was built for the Russian Government, and was the first boat to obtain a speed of 30 knots. A larger boat, built in 1900, for the Japanese Government—over 220 feet long—obtained a speed of nearly 32 knots, and the next year a vessel was built for the Swedish Government which obtained 32½ knots.

Lately the size and speed of these vessels, with much improved internal arrangements and fighting power, have greatly increased, until 30 knots has become a practical speed and 40 knots or over is well within view.

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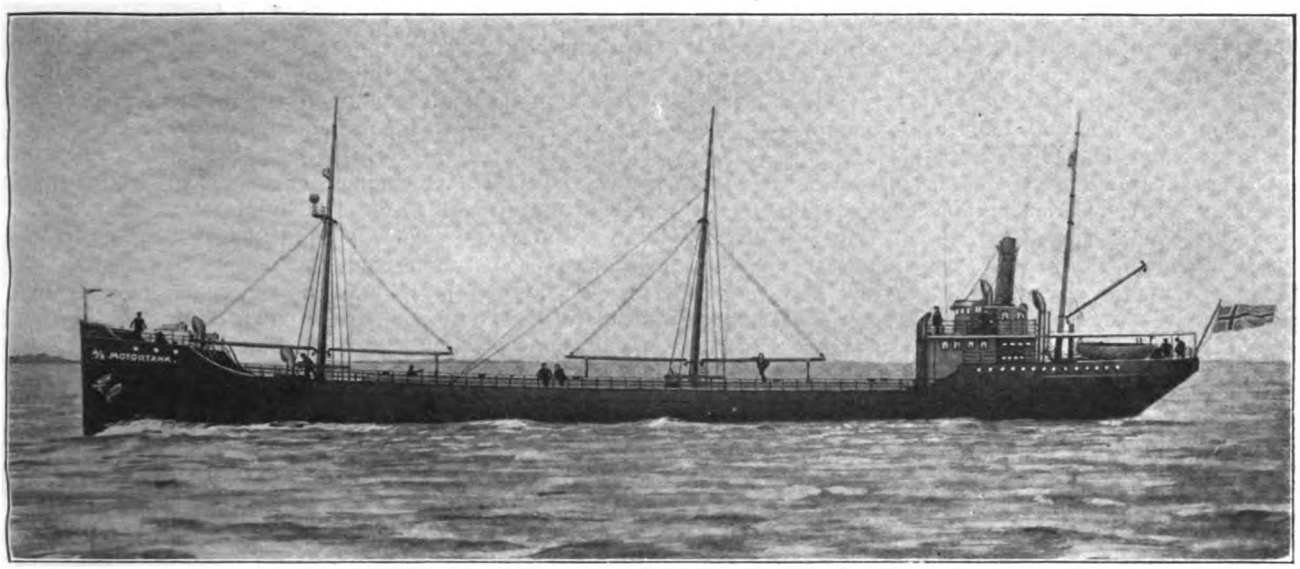

Fig. 2.—Motor Tank Ship, Equipped with Diesel Engine

building motor ships, it is only natural that orders for steamers should be placed, except in the case of small vessels, where it has been found to be quicker to build a wooden motor auxiliary than a small steel steamer. Again, freight rates are so high and shipowning profits so huge that economical operation now becomes a minor consideration. Just at the moment shipowners only have their eye on the present, and seem to be paying little regard to the future. A shipowner will argue, "What matter if I can save $50,000 (£10,250) per annum with a motorship if I have to wait two months longer for the ship, during which period a steamer will earn me $100,000 (£20,500)?" If only shipowners were in the position to construct motorships as fast as steamers, the entire situation would have been changed. The tide will turn, however, and when freight rates drop there is bound to be a rush to build motorships, or to convert steamers to Diesel power, because economy of operation then will be of the greatest importance to shipowners.

Another retarding factor to the motorship development has been the cutting off of Germany from the seas. Just prior to the war the big German shipping men had planned out some extensive motorshipping schemes along this line, and altogether six of the most important Teutonic shipbuilders actually had completed large ocean-going mercantile motorships and their Diesel engines. They are: Blohm & Voss, the Rehierstieg Company, the Weser Company, the J. C. Tecklenberg Company, Fried. Krupps and the Frerichs Company, while a host of smaller concerns were engaged in more modest attempts. I have reason to believe that no small progress has been made in Germany during the war, and it practically is certain that German shipowners have plans for extensive motorship construction after the war, when they will be forced to use the most economic means of transportation of freight. In fact, one of the directors of the Cosmos Line, of Hamburg, who has been in America since the outbreak of war, has taken the opportunity of the period of idleness to make a most exhaustive study of the entire motorship situation, and there are not many such vessels whose

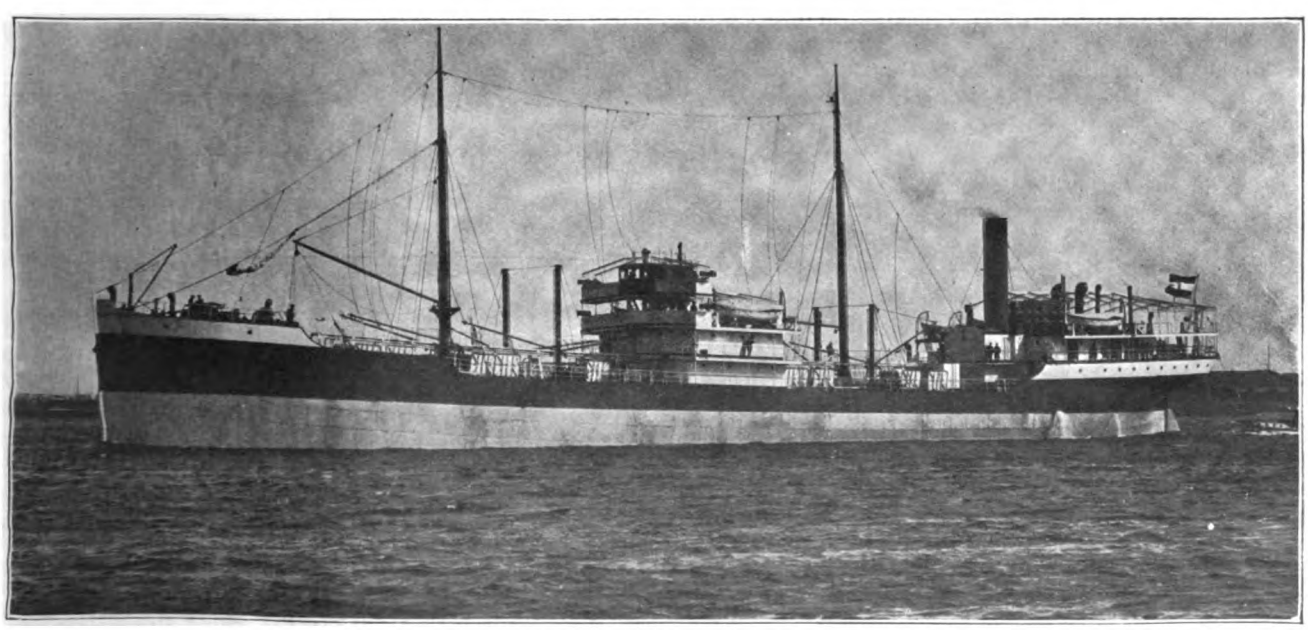

Fig. 3.—Motorship *Artemis*

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operations he has not followed; consequently he is a firm believer in the motorship and his company has plans for the establishment of a large motorship fleet of cargo carriers when peace again reigns.

No country has been more difficult to obtain news from than Russia, and the only information that I have been able to obtain since the outbreak of war is that the Caucasus & Mercury Company of Petrograd has decided entirely to abandon steam and revert entirely to Diesel-engined motorships. The war has interfered with their building program to a considerable extent, consequently they only have twenty Diesel-driven craft in service, a dozen of which are large twin-screw passenger vessels of 1,200-brake horsepower (about 1,500-indicated horsepower).

The same policy of entirely abandoning steam machinery has been adopted by the East Asiatic Company of Copenhagen who, by reason of experience, are so sure of the success of the marine Diesel engine, that they placed orders for motorships for delivery in five years' time; also, they converted three steamers to motor power. They even went further than this and sold eleven other large steamships and ordered motorships in their place.

ENTIRE OUTPUT OF DANISH MOTORSHIP BUILDER SOLD UP TO 1922

I do not think that there is a steamship owner in America who has sufficient confidence in steam-driven freighters that he dare order (at to-day's high prices) a 10,000-ton oil, or coal-burning cargo steamship for delivery in five or six years' time, yet Burmeister & Wain, the Danish motorship builders, have their entire capacity (one ship per month) definitely ordered up to 1922, and not a single steamer will be among them—all will be Diesel-driven motor vessels. One day American shipowners will wake up, and perhaps then it will be too late.

Shipbuilding of all kinds has suffered most severely in Holland, due to that country being unable to obtain any materials whatever from Germany, France or Great Britain. The Netherlands Shipbuilding Company and the Werkspoor Works have orders in hand for a number of Diesel-driven motorships, of which some are for Norwegian owners. Had the material market been better for Holland its shipbuilders would have undertaken orders for a much larger number of Diesel vessels, delays in receiving materials from America making the process of launching and completing ships much slower than in normal times, consequently the motorship production severely has suffered, which indeed is unfortunate, because Holland has turned out some of the world's most successful motorships.

MOTORSHIPS BUILDING IN NORWAY

Norway has shown the strongest inclinations of all countries to adopt motorships, and in this country alone Norwegian shipowners have a large number of wooden auxiliaries on order, and, as just mentioned, have a number of full-powered, steel-built motor freighters building in Holland. At the end of last year Norway, according to the "Norske Veritas," had 2,036 ships measuring in excess of two and a half million tons, of which 2,143,802 tons consisted of steamers and motorships. How many of these are motorships is not given, but in 1915 her motorship fleet was increased by seven vessels totaling 21,000 tons, so, for 1916, it is fairly safe to assume ten additional motorcraft of 35,000 tons aggregate. On January 1 of this year there were four full-powered steel Diesel motorships of 4,375 tons each under construction, and four full-powered steel Diesel motorships of 4,675 tons each under contract, but not begun, with Norwegian yards. There also were two wooden motorships building, and two under contract. Considering that there were only 77 mercantile ships of all kinds under construction at that date the proportion of motorships is not at all disheartening, if one considers the present conditions.

Practically all the British shipyards have licenses to build marine Diesel engines, or else have produced an engine of their own design; but in most cases the war has entirely upset developments, and now that a "rush program" for constructing standardized vessels has been put through the builders in most instances have been obliged temporarily to lay aside Diesel engines because of their facilities to turn out steam machinery in much quicker time. However, Harland & Wolff have made great preparations for turning out standardized Diesel ships, and already have laid down four freighters of 13,000 tons each, so that the motorship industry is not quite dormant. After the war we can look to seeing large numbers of motorships being built in the British Isles.

Lastly, we will turn to the motor shipping development in our own country, where just at the moment mysterious inquiries are being put out for 200 wooden motorships of about 2,000 tons deadweight capacity in one batch, and another inquiry consists of a number nearly as large, but of vessels of about 4,000 tons deadweight capacity. Who, or what, is at the back of this is hard to say, and may be revealed by the time this appears in print.

AMERICAN SHIPBUILDERS PREPARED TO BUILD DIESEL MOTORS

Full-powered motorships of large size have met with little attention in this country, although since the war three great shipbuilders—namely, the Newport News Shipbuilding & Dry Dock Company, the Wm. Cramp Ship & Engine Building Company, and the New York Shipbuilding Corporation—have acquired European Diesel constructional licenses. Pressure of other work and lack of support from shipowners, however, have prevented them from making the progress that they may have desired. Cramps has laid down a motor freighter of about 12,000 tons and the Brooklyn Navy Yard has completed the 15,000-ton displacement motor tanker *Maumee*, otherwise there is no large motorshipping development to report.

However, the last year has seen a record in the placing of orders for motor-driven auxiliaries of wooden construction, the majority of which are of from 2,000 to 3,000 tons deadweight capacity; also, there are a number of full-powered wooden ships of about this size now building, all of which will be motor driven. The entry of the McIntosh & Seymour Corporation, of Auburn, N. Y., into the marine Diesel engine field is to be recorded, and their first order was for eight 500-brake horsepower engines, for four ships for the Clinchfield Navigation Company, of New York City. Since the war several other companies have entered the marine Diesel engine field, including the Winton Company, of Cleveland; the Atlas Company, of Oakland, Cal., and the Southwark Foundry and Machine Company, of Philadelphia.

RELIABILITY OF MARINE DIESEL ENGINES.—"Modern marine Diesel engines have reached a stage of reliability so that there is not the slightest doubt that in a few years' time they will be in advance of the steam engine. At present there are motorships crossing the Atlantic running as regularly as steamships, keeping as good, if not better, time than steamers and coming through the heavy weather without any hitch to the motors. I would rather be with a Diesel engine in heavy weather than with a steam job."—J. E. COLE, chief engineer M. S. *Abelia*, in *Motorship*.

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Standard Specification for Triple Expansion Marine Engines for Cargo Boats*

Compiled by the Council and Members of the North-East Coast Institution of Engineers and Shipbuilders, 1917

IN the present crisis of the country's history it is the duty of all of us to bethink ourselves and consider how we are to hold our own in the approaching contest for supremacy in the industrial world. As shipbuilders and engineers it is specially incumbent on us to look forward to what is likely to happen after the war, and to prepare for the new conditions as far as we possibly can. Intensified and organized competition from abroad is the least that may be expected. As to whether this will be met or not depends on whether our manufacturers so bestir themselves as to procure not only vastly increased economy in production, but also increased efficiency of their products. Labor questions do not come within our present scope, and we therefore confine ourselves to the scientific and technical factors of the problem, the influence of which cannot well be overrated. Old designs and easy going or antiquated methods will be rigidly overhauled, and, where necessary, must be brought up to date under the guidance of the latest research and reliable experience.

Animated by those views the council of the Institution, after grave consideration, have taken the first step in what they trust may develop into a beneficial and helpful enterprise, and hereunder present for discussion by the members the draft of the guidance specification for reciprocating triple expansion engines intended for moderate-speed cargo boats engaged in general trade. The specification is based on the best practice of the day and the district, and the object in view is the ultimate standardization of parts. There is no intention whatever to change accepted and successful practice, but merely to reduce that practice to a common basis, and to add to it when desirable or necessary, in order to raise performance to the highest pitch of efficiency.

It is hoped that ultimately the specification will be extended to include not only the main engine proportions and scantlings, but also the boilers, auxiliaries and other details. Quadruple expansion engines and geared turbines, as well as internal combustion engines, will also be dealt with as time permits.

The council suggest that the present installment, as and when approved by the members in general meeting, shall be known as "The North-East Coast Institution Specification (1917) for Cargo Boat Triple Expansion Engines." It is hoped that it will be accepted by marine engine builders, and that it may prove beneficial not only in securing the maximum rate of progress in technical advance, but also in promoting convenience and despatch in the purely business sphere. The council propose that discussion in the meantime be restricted to the subject matter of the present draft, and that an annual revision be made in order that the specification may be kept thoroughly up to date, and may command the confidence and promote the ultimate interests of all concerned.

Specification

1. *Indicated Horsepower.*—For calculation purposes in this specification and in average sea conditions the I. H. P. is to be found as follows:

$$I.\,H.\,P. = \frac{D^2\,S\,N}{700}$$

D = diameter of low-pressure cylinder in inches,
S = stroke in feet,
N = revolutions per minute. Found as per section 2.

The divisor is adjusted for a referred mean pressure of 30 pounds per square inch.

2. *Revolutions.*—

$$N = \frac{32\,(S+4)}{S}.$$

3. *Boiler Pressure.*—180 pounds per square inch (gage).

4. *Ratios of Cylinder Areas.*—Ratio for 180 pounds pressure.

H. P.	M. P.	L. P.
1	About 2.74	About 7.5
	1	" 2.74

5. *Cuts Off at Sea Power.*—

About 57.5 percent.	57.5 percent.	55 percent.

6. *Speeds of Steam.*—The mean steam speeds to be calculated as follows:

$$\frac{\text{Area of cylinder in square inches} \times \text{piston speed in feet per second}}{\text{Area of pipe, port or opening in square inches}} = \text{speed in feet per second.}$$

Table of mean steam speeds in feet per second:

	H. P.	M. P.	L. P.
Main steam pipe	110	—	—
Port opening	110	150	240
Steam ports	80	85	100
Exhaust passage or pipe	60	65	75

Width of Steam Ports.—Width of ports to be about 0.8 of diameter of cylinder.

7. *Maximum Load.*—The maximum load on main working parts to be taken as the product of the area of H. P. cylinder in inches and the boiler pressure in pounds per square inch (gage).

8. *Crankshaft.*—The diameter of crankshaft in body is to be nearest ⅛ inch above Lloyd's rule, and the proportions of the remaining parts to be not less than the following:

(1) Diameter of crankpin to be equal to diameter of shaft.

(2) Diameter of crankshaft in web to be equal to diameter of shaft plus ½ inch.

(3) Diameter of webs to be equal to diameter of crankpin by 1.85.

(4) Thickness of webs to be equal to diameter of shaft by 0.62.

(5) Thickness of couplings to be equal to diameter of shaft by 0.25.

(6) Six coupling bolts to be used for shafts up to and including 15 inches diameter. Nine coupling bolts to be used for shafts above 15 inches diameter.

*(7) Diameter of pitch circle of coupling bolts to be 1.43 diameter of crankshaft.

*(8) Diameter of coupling bolts to be equal to:

* Paper read before the North-East Coast Institution of Engineers and Shipbuilders, on February 8, 1917.

* These two rules may be varied, provided that equivalent strength is given.

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$$0.7 \times \sqrt{\frac{\text{diameter of shaft}^3 \text{ in inches}}{\text{number of bolts} \times \text{diameter of pitch circle in inches.}}}$$

Bolts to be parallel.

9. *Length of Connecting Rod.*—Length of connecting rod between centers to be twice the stroke or four times the crank radius.

Diameter of Connecting Rod.—Connecting rods may be made parallel, same diameter as piston rod body.

Connecting Rod Top Ends.—Connecting rods to have single top-end gudgeons for all engines having H. P. cylinders of 25 inches diameter and under.

10. *Crosshead Guides.*—Main crosshead guides to be of the single type in all sizes of engine.

Load on Main Crosshead Guides.—Maximum load in pounds on crosshead guides to be taken as:

$$\frac{\text{Area of H. P. cylinder in square inches} \times \text{boiler pressure in pounds per square inch (gage)}}{4}$$

11. *Maximum Pressures on Principal Bearing Surfaces.*—

	Pounds Per Square Inch
Main bearings	250
Crankpins	500
Crosshead gudgeons	1,000
Guide shoes (ahead)	55
" " (astern)	110

Diameter by length to be taken as area of bearings.

Overall length by overall breadth as area of guide shoes.

12. *Maximum Stresses on Principal Working Parts.*—

	Pounds Per Square Inch
Ingot steel piston rod at screw	6,000
Piston rod body (after deducting ¼ inch from diameter to allow for returning)	3,000
Piston and connecting rod bolts at screw	5,500
Main bearing bolts	4,500
Main bearing keeps (if forged)	6,000
Connecting rod bottom end keep (if forged)	7,500
Piston rod keep (if forged)	7,500

(The keeps are calculated as beams with distributed load and supported ends.)

13. *Valve Gear.*—The valve gear sizes to be determined from the load on the I. P. slide valve spindle, calculated as follows:

Load in pounds = 0.165 [54 (A-B) — 9 C],

Where A = area of face of I. P. valve in square inches,

B = combined area of steam ports in valve face in square inches,

C = combined area of exhaust ports in valve face in square inches.

Valve Spindles.—Diameter of valve spindles at gland to be not less than

$$\frac{\text{Diameter of piston rod at gland}}{2} \times \tfrac{5}{8} \text{ inch.}$$

Maximum Pressures on Bearing Surfaces of Valve Gears.—

	Pounds Per Square Inch
Link block gudgeon	500
" " slippers	300
Eccentric rod top end pins	500
Eccentric sheaves (ahead and astern)	85

14. *Thrust Block.*—When of horseshoe type the pressure on thrust collars not to exceed 70 pounds per square inch when calculated from indicated thrust, which is determined as follows:

$$\text{Pounds indicated thrust} = \frac{I.\,H.\,P. \quad 33{,}000}{\text{Pitch in feet} \times \text{revolutions per minute}}$$

15. *Circulating Water.*—The amount of circulating water supplied to be forty times the feed, taking the latter at 15 pounds of steam per indicated horsepower per hour.

16. *Main Engine-Driven Reciprocating Circulating Pump (Double-acting).*—To be proportioned to deliver the above quantity of water at a displacement efficiency of 80 percent.

17. *Maximum Speeds of Circulating Water.*—The speeds of circulating water are to be calculated as follows:

$$\frac{0.8 \text{ area of bucket in square inches} \times \text{bucket speed in feet per second}}{\text{area of passage in square inches}} = \text{speed of water.}$$

Approximate Speeds in Feet per Second.—

	Feet Per Second
Main injection	9.0
Passages in pump	5.0
Valve grids	6.0
Past lift of valves	9.5
Discharge pipe	7.5

18. *Air Pump.*—Capacity of air pump not less than one-sixteenth of the capacity of L. P. cylinder.

19. *Main Engine-Driven Feed Pumps.*—Capacity of *each* engine-driven feed pump 1/700th of capacity of L. P. cylinder.

20. *Pump Gear.*—Load on pump gear to be calculated as follows: Load in pounds = 25 (area of air pump bucket + area of circulating pump bucket) + 15 (area of both feed pump rams + area of both bilge pump rams). All in square inches.

Maximum Pressures on Pump Gear Bearing Surfaces.—

	Pounds Per Square Inch.
Pump link pins	400
Engine link pins	300
Pump lever center gudgeon bearings	250

For cargo vessels of large tonnage it is recommended that the circulating and feed pumps be independently driven pumps.

21. *Utilization of Heat in Exhaust Steam from Auxiliary Engines.*—A source of very considerable economy in a marine installation being the complete absorption by the feed water of the heat in the exhaust steam from the various auxiliaries, including the steering engine, electric-light engine and evaporator, such a vacuum should be carried in the main condenser as will enable this to be effected in all seas in which the vessel trades. A vacuum of 27 inches maintained in the steam space of the condenser, the temperature of the sea being 70 degrees F. (barometer 30 inches) has been found to meet these requirements on an average cargo boat.

22. *Cooling Surface.*—In determining the amount of cooling surface per indicated horsepower average at sea, provision should be made for the rapid initial degrading effect of oil and scale on the tube surfaces, and also for the permanent prejudicial effect on the condensing efficiency of the residual air in the condenser.

23. *Air Extraction by Steam Jet.*—When a steam jet is employed for the extraction of air, and a suitable design of condenser is adopted, the greatly increased efficiency of the condensing surface enables a higher temperature of feed to be obtained, and for a given vacuum the sizes of air pump and circulating pump to be considerably reduced, thereby saving pumping power and total weight.

24. *Pressure Losses in Vacuum System.*—It is important to minimize the loss in absolute pressure between the steam space in the condenser and the mean vacuum line as shown on the L. P. indicator diagram, and also the loss between the steam space in the condenser and the air-pump suction pipe.

In good practice (*a*) the vacuum line should scale 12¼

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pounds per square inch below the atmospheric line when the vacuum in the steam space of the condenser is 27 inches; (*b*) the speed of steam over the condensing surface should be such that the total resistance through the condenser does not exceed one-tenth of an inch of mercury or 1.36 inches of water, as measured by a resistance gage.

25. *Prevention of Delivery of Oil to Boilers.*—It is desirable that the oil should be separated from the auxiliary exhaust steam before it is used to heat the feed water, but in any case the feed water must be passed through a satisfactory filter before delivery to boilers.

26. *De-aeration of Feed Water.*—Means should be provided for the de-aeration of feed water before it enters the boiler, with the object of preventing corrosion.

27. *Prevention of Heat Loss by Lagging.*—Heat loss by radiation from unprotected surfaces being a very appreciable factor in the ultimate economy of a steam installation, the lagging of boilers, steam pipes, cylinders, auxiliary exhaust pipes and feed pipes should receive expert attention in order to promote efficiency by means of an adequate thickness of non-conducting material applied in a workmanlike manner.

Recent Progress in Dredging Machinery*

Brief Descriptions and Performance Records of Latest Types of Bucket, Suction and Dipper Dredges

BY WILLIAM BROWN

THE paper deals with bucket dredgers, suction dredgers of the "cutter," "drag," and "moored" types, and dipper dredgers.

Each of these types, within its limits, is recognized as being best suited for particular classes and conditions of dredging, and the vessels described in the paper have not been selected because of any phenomenal dredging done by them, but because special attention has been devoted to their design to meet the several conditions of their intended use.

With regard to the question of dredging costs, no fair comparisons can be made unless due regard is had to all the items—labor, coal, oil and stores—and to the physical conditions met with. Comparisons are only of value when the conditions are fully explained, when all corresponding details are included in the charges, and when the methods of accounting at the various ports are reduced to common terms.

Bucket Dredgers

The bucket hopper dredger *Silurus* is taken to represent the most modern dredger of the bucket type, and particulars are given of the work done by the dredgers *Corozal, Kuphus* and *Octopus.*

The *Silurus* is a twin screw bucket hopper dredger built of steel to Lloyd's requirements, for the port of Bombay.

	Feet
Length between perpendiculars	260
Breadth, molded	46
Depth, molded	20

The hopper has a capacity of 1,500 tons. The steam generating plant consists of two marine cylindrical multitubular boilers, and there are two main engines of compound surface condensing type for propelling the vessel, or for driving the dredging gear as required. The gearing between the main engines and the upper tumbler is so arranged that with a constant piston speed of the main engines two different speeds of buckets can be obtained. Two sizes of buckets are provided, one set of 42 cubic feet capacity for excavation in soft material, and a smaller set each of 22 cubic feet capacity.

Clay-Cutting Suction Reclamation Dredgers

These dredgers give satisfactory results in all classes of clay, as well as in free material, and on occasion cutter dredgers have been employed on stiff blue clay and on hard chalk, which have been found a severe test of the capabilities of powerful bucket dredgers. The cost of repairs and renewals in cutter dredgers when working in hard material is less than with bucket dredgers, owing to their wearing parts being much fewer, the only parts of importance subject to hard wear being the cutter blades and liner plates of the pump, as against the buckets, pins and bushes, tumblers, and ladder rollers of a bucket dredger.

The clay-cutting suction dredgers *Jinga* and *Kalu*, which are described, were ordered by the Bombay Port Trust for carrying out a very large reclamation scheme undertaken by them.

These vessels were designed to be capable of dredging 2,000 cubic yards of soft clay and mud per hour from a depth of 30 feet, and discharging the material so dredged to a distance of 4,500 lineal feet on shore. The dredging depth was subsequently increased to 40 feet. Their dimensions are:

	Feet
Length on main deck	205
Breadth, molded	42
Depth	13

The dredging pump is driven by a set of triple expansion inverted direct acting, surface condensing engines. The boilers are four in number, of the cylindrical multitubular type and provided with Howden forced draft. The cutter is of rotary pattern.

In the Twante Canal, connecting Twantewa with Rangoon, suction cutter dredgers were employed to cut the clay that formed the bank and bed of the canal and pump it through a floating pipe line to alongside of wherever it was desirable to deposit it upon the bank, and then raise and discharge it by means of a floating terminal pontoon with a raised pipe overhanging the bank.

Three suction cutter dredgers, each with 1,000 feet of floating pipe line and a terminal pontoon with 80 feet overhang, were ordered by the Indian Government. The *Oswald* and *Campbell*, the two smaller boats, both have 24-inch diameter suction and discharge pipes, and the *Lees* has a suction pipe 30 inches in diameter and a discharge pipe 27 inches in diameter.

Moored Suction Dredgers

At Durban, where suction dredgers of the moored type have been employed with excellent results, the depth of

* Abstract of a paper read before the Institution of Civil Engineers, on January 9, 1917.

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water at the entrance in 1884 was 7 feet 2 inches, which had become 36 feet 5 inches in 1914, mainly as a result of dredging. Up to the end of the year 1914 the total volume of solids removed at Durban amounted to 81,737,292 tons.

The chief difficulty of dredging on the bar at Durban is that the work has to be carried out in the open sea and subject to heavy weather. To meet such conditions, the suction pipes of the Durban dredgers are in two parts, joined together by flexible armored piping spanned by universal joints. The upper end of the suction pipe is carried on a trunnion bearing near the deck, and the nozzle end is controlled by hydraulic hoist gear designed to maintain the two lengths of pipe relative to each other in the same line of axis when working at any depth. The hoisting gear is so arranged that when the length of pipe below the joint deviates from its axis with the upper length, the hoisting gear automatically raises the lower length, thus allowing the lower end to clear the obstruction which caused the deviation.

At Lagos, a pump dredging plant is used in connection with deepening the bar at the entrance to the harbor, which has hitherto been subject to considerable fluctuations. The dredgers employed particularly for this part of the work at Lagos are the pump hopper dredgers *Egerton* and *Sandgrouse*. In their main features they are much alike, the *Sandgrouse* having a hopper capacity of 1,800 tons, while the *Egerton's* hopper capacity is 1,200 tons.

The dimensions of the *Sandgrouse* are:

	Feet	Inches
Length	291	0
Breadth	45	0
Depth	19	9

and she is fitted with two sets of triple expansion, surface condensing engines driving twin screws, and one set of triple expansion engines directly connected to the dredging pump. Steam is supplied by three marine cylindrical multitubular boilers. The suction pipe arrangement permits of entire flexibility in any direction.

The remaining dredging plant at Lagos has been principally provided with a view to the reclamation of certain swamps. The reclamation dredger is specially arranged for pumping from barges alongside by means of two independent dredging pumps so arranged that they may work either singly or in series, depending upon the distance the material is to be discharged.

The suction cutter hopper dredger for Lagos, now under construction, is fitted with one set of triple expansion surface condensing engines arranged to drive the dredging pump or the propeller, as may be required.

The outboard suction pipe is fitted with a special drag nozzle for use when dealing with compact sand, while a spiral rotary cutter is provided for dealing with clay and harder material.

A special feature in this vessel is that four independent automatic mooring machines, four capstans, and one steam windlass are provided for mooring purposes.

Drag Suction Dredgers

The *M.O.P. 210.C* and *M.O.P. 211.C* are selected to illustrate the drag suction or moorless type of dredger. They were specially designed and constructed to meet the conditions prevailing at Buenos Aires, and the character of the material there met with.

These vessels have a hopper capacity of 1,650 cubic meters and are each fitted with four sets of triple expansion engines. The engines are arranged in pairs, so that all four sets are available for driving the dredging pump or the propellers separately, or two sets may drive the dredging pumps and two sets drive the propellers at the same time, as may be required. Steam is supplied by four cylindrical multitubular boilers.

When commencing work the vessel is steamed slowly ahead on the desired line of excavation, and the drag nozzle is lowered into the material until the inlet opening of the nozzle is completely sealed by the clay to be raised, so that the load on the hopper is made with the minimum amount of added water.

The drag suction dredgers *Cormorant* at Rangoon and *Canterbury* at Lyttelton are of the same type as those employed at Buenos Aires. The *Cormorant* is 204 feet long, 38 feet molded breadth, and 17 feet 6 inches deep; hopper capacity, 27,000 cubic feet, mean draft, 14 feet 3 inches, and speed per hour on measured mile, 9½ knots. She is fitted with patent steering jets, so that the vessel can be steered entirely independent of the rudder. The dimensions of the *Cormorant* and the *Canterbury* are alike. The only difference of vital importance is the arrangement of the propelling and pumping machinery. In the *Cormorant* one pump was fitted driven by independent engines, while two sets of engines were fitted for propelling, each driving one twin screw direct. In the *Canterbury* the machinery arrangements are similar in all respects to the arrangements already described for dredgers *M.O.P. 210.C* and *M.O.P. 211.C*.

Dipper Dredgers

To illustrate this type of dredger, the modern 15 cubic yard dipper dredgers *Gamboa* and *Paraiso*, employed on the Panama Canal, have been selected.

The ability of these dredgers to dig into a bank of shale, sandstone, lignite, or any of the softer rocks, to dispose expeditiously of a rock too large to pass through the dipper, to dig to 50 feet depth, and load into scows of almost any size, makes them very valuable tools for work of this class. They are capable of dredging 7,000 to 10,000 cubic yards of rock per day of twenty-four hours, depending on the degree of hardness of the material. The material handled by them is loaded into bottom-door steel dump scows.

The principal features of the *Gamboa* and *Paraiso* are the following:

Each dredger has two dippers respectively of 15 and 10 cubic yards capacity. The dipper handle is 72 feet long. The main hoisting engines are of the twin tandem compound type. The winding drum is graduated so as to give a low speed when digging. The swinging engine is of the double cylinder high pressure type, with steam-operated link reversing gear. The dredger is fitted with three spuds. The forward spuds are placed far enough back to allow a swing of 180 degrees for the boom. The third spud is placed centrally at the stern.

S. S. Minnesota Enters Transatlantic Service.—The American freight steamer *Minnesota*, of 20,718 gross tons, sold recently by the Great Northern Railway Company to the International Mercantile Marine Corporation for a sum reported at $2,750,000 (£564,000), sailed on February 15 from San Francisco for New York and London. The vessel, which has been laid up in San Francisco for over a year, has been reboilered by the Union Iron Works Company and has been fitted for the transatlantic trade. She is the largest vessel thus far to pass through the Panama Canal.

Government Shipbuilding Reports Discontinued.—According to notices just given out by E. T. Chamberlain, Commissioner of Navigation, publication of the weekly shipbuilding statements formerly issued by the Bureau of Navigation is discontinued indefinitely.

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Changes and Advances in Marine Auxiliaries

Increased Speed, Better Materials, Improved Workmanship and Adoption of Rotary Power Units Distinctive Features

BY W. D. FORBES

IT is an interesting, yet not difficult, task to consider the changes and advances made in marine auxiliaries since the first issue of MARINE ENGINEERING was laid before the engineering world, as the two decades which have passed come well within the memory of many. It would, of course, be impossible to go into the details of such improvements, so this article will confine itself to generalities, but from the experience of the past twenty years it is possible and quite proper to suggest one or two lines of future improvements in ship auxiliaries.

One of the first things to impress one in studying the matter would be the advance in speed of the various auxiliaries. This would be very apparent by comparing the slow-moving, direct-acting pump to the high-speed centrifugal pump—motor or turbine driven. Probably there never was a more unsatisfactory thermo-dynamic engine than the direct-acting pump, and there certainly never was a more widely used and popular mechanical article put upon the market. To offset its disadvantages it has simplicity, compactness and low cost to recommend it. It has been improved in design since its introduction, but it has not been improved in its workmanship.

INCREASE IN SPEED

The increase in the speed of auxiliaries can be clearly traced partly by the enormous advance in the quality of material, and the United States Navy should be given the honor of having brought about, very largely, this condition. When its specifications first demanded the high-grade material now common, steel manufacturers fairly gasped at the requirements, but the Navy was insistent, and to-day the then supposed "impossible" demand has become the possible. About twenty years ago the Navy was in what might be called the 88-10 and 2 period and somewhat hidebound in its ideas. To-day this condition has entirely changed and the standard set by the Navy has worked its way into the commercial world.

Increased speed and better material would in themselves make toward an advance, but, coupled with these, workmanship has marvelously improved. The introduction into general use of hardened material, machined by the emery wheel, has raised the standard of wearing quality by the production of truer surfaces. The selection of composition after many trials, both in the laboratory and empirically, has aided in making all auxiliaries far more certain in their action for long periods of time. Since the days of the chase of the *Itata* the constant breaking down of blower engines, as then noted, is no longer to be expected, whether the blower is run by electric motor, steam turbine or reciprocating engine, and it can be truly said that certainty of functioning of all auxiliaries is most marked in the twenty years that have passed. To-day the marine engine room is not filled with men whose hearts are in their mouths during the voyage for fear of auxiliary breakdowns.

During the period named the introduction of electric light aboard ship has contributed more to the safety and comfort of all hands than any single advance. Electric generators and their motive power units are now thoroughly reliable, and it, of course, follows that the electric motors are equally dependable. Also satisfactory storage batteries are now obtainable, adding greatly to the comfort of those in charge.

The continuous rotary motion in moving machinery is self-evidently a condition which would make for smooth running and lasting qualities in driving ship auxiliaries. The first of these was the electric motor, and when coupled to a fan, and the plant was in proper balance, there was no vibration and but little noise. The stillborn child of years ago, the steam wheel, followed the motor as a continuous drive, and it was brought to life and has become a most robust child, although by no means yet a man; for it must be remembered that, like human growth, it will take the steam turbine time to mature. Further, it can be safely predicted that the steam turbine will not become just a man, but a giant.

The certainty of action and lasting qualities of auxiliaries have been greatly aided by the improvement in the quality of lubricants obtainable. Especially has their value been added to by their application to bearings through the "forced system," as it is called, of lubrication. Without these important conditions the advance in design, material and workmanship would have availed little comparatively.

By means of centrifugal pumps of several stages pumping water into the boilers has been robbed of the danger of oil being introduced into them, and this is no mean gain. We have had a very satisfactory advance also in the increased efficiency of centrifugal pumps.

In all the designs referred to there has been great care taken to make inspection, and even repairs, easier than heretofore. In considering all continuous rotating mechanical appliances, however, the matter of repairs has changed and it might be broadly said that a rotative unit will either work or it will not. When it does not work it generally has to be entirely replaced, while with reciprocating units usually one particular piece has given out which can be replaced with comparative ease.

INTERCHANGEABILITY DESIRABLE

To point out now the things which have not been done in the past two decades, but which should have been done, or at least started, it might be said that more thought should have been given to making ship auxiliary units interchangeable; that is, the engineering world should strive to have makers of various auxiliaries hold to certain standards which would allow, say, a pump outfit made by White interchangeable, when of the same capacity, with one of Brown's make, as far as its holding down bolts, steam supply, exhaust, suction and discharge can be made uniform as to spacings, position and sizes. What this would mean will be readily understood after a moment's thought by shipowners, engineers and men in the engine room. It would mean economy both in time and money, which is the vital point in all business enterprises, whether afloat or ashore.

There is also room for the naval architect to improve conditions by having standard positions for the various auxiliaries, as for instance, having a boiler injector always located in a certain position and its control so

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manipulated that one make would not require one movement in order to start it while another make would have to be handled in just the opposite direction. It is, of course, understood that ships vary in their engine room layout and this suggestion of standard position could not be adhered to, to the inch, yet condensers, for instance, could always be put on the port side and electric lighting plants on the starboard side forward. Especially it would seem that this idea should be considered by the Navy, for obvious reasons.

Evidently with the increased speed, better design, material and workmanship there has been a gain in weight and space. Considering the condenser as an auxiliary it seems rather strange that there has been so little advance in its construction. Some years ago there was brought to the writer's notice a plate condenser which on test showed a very decided advance in efficiency over the regular tube, so well known. If my recollection is correct, there was a saving in both weight and space amounting to 80 percent, a most desirable gain. The invention was a Swedish one, but there must have been some reason why it did not come before the public commercially, and it is to be regretted that it was not followed up.

The use of the internal combustion engine as an auxiliary has at least one or two places aboard ship; that is, for wireless communication and, further, for running the lights aboard ship in case of accident which would result in flooding the engine room. Such an engine can be placed on the upper deck, where it will continue to operate until the ship sinks, thus materially aiding in getting boats safely overboard and preventing confusion which would inevitably occur in darkness.

To recapitulate, it can be said that auxiliaries have advanced in twenty years in efficiency, wearing qualities and certainty of action, coupled with a gain in weight and space.

Improvements in Marine Engine Room and Fire Room Auxiliary Machinery

Increased Steam Pressures and Use of Superheated Steam and Oil Fuel Responsible for Changes in Pumping Machinery—Feed Heaters

THE last twenty years has seen a rapid change in all lines of pumping machinery in marine circles. Increased steam pressures, the use of superheated steam, and the increased use of oil for fuel have been the three chief causes for this change, and the nature of the changes is apparent from the following information supplied by the Worthington Pump & Machinery Corporation.

As fire room auxiliaries the functions of the pumps have been added to by the demand for suitable designs for pumping oil from ships' storage tanks to the settling tanks whence the fire pumps take their supply, forcing it through the heaters to the burners. At the burners it is necessary to atomize the oil either by mechanical means, better known as high-pressure service, or by the introduction of steam or air, known as low-pressure service.

Fig. 1 shows a typical installation of two duplex pumps and receiver, all mounted on a common base. The receiver contains the heating coil to which the exhaust steam from the pumps can be passed. A similar arrangement is also made up of two single pumps.

Fig. 2 shows the design of the oil-pumping unit particularly adapted for marine and navy service. It is double in every respect, so that all parts for one complete outfit can be cut out and not interfere with the continuous operation of the plant. The heaters are of the six-pass, multi-current type, which insures the greatest degree of heat with a minimum amount of steam.

For installations where floor space is very limited, double units similar to Fig. 3 are in common use. These pumps can be bolted either to a bulkhead or column and oil pumped through a heater of either horizontal or vertical multi-current type.

Fifteen or twenty years ago boiler pressures began to rise, until to-day pressures of 250 and 300 pounds per square inch are in common use. In addition to this, the practice of superheating the steam has come into common use. Coincidently with these changes, marine engineers have demanded a restriction of the use of lubricants in the steam cylinders and valve chests of auxiliary pumping machinery. Some have carried it even to the stage of totally dispensing with the use of oil, graphite or other lubricating mediums.

These changes necessitated radical re-designing of both steam and water ends of direct-acting pumps and other marine auxiliaries. The flat unbalanced slide valve has

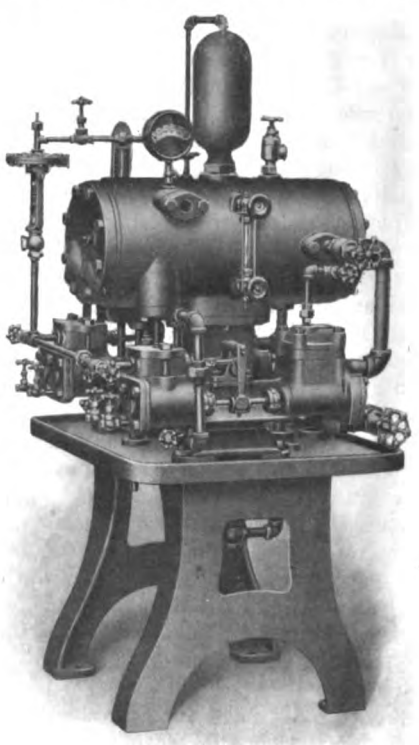

Fig. 1.—Duplex Pumps for Low-Pressure Oil-Burning System

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always been preferable to the piston valve, owing to its steam tightness, but the increased pressure acting on the necessarily large slide valves causes an excessive load on the valve gear and its use becomes impracticable. The piston valve, being of the balanced type, partly remedied this trouble, but had the objection of leaking steam after the piston became slightly worn. The advantages of both of these types have been used in different combinations, developing from the original stage, as shown in Fig. 4 to the latest styles, of which Fig. 5 shows a typical case.

this type is the small auxiliary mechanically-operated valve, which, when operating under high steam pressure, results in only a light load on the operating mechanism. The main valve has the added advantage of being of the flat type and always steam-tight, and, in addition, being operated by steam-thrown auxiliary plunger.

The ever-increasing demand in the marine service for better steam economy has led to the further re-designing of direct-acting steam valve gears, and now a very successful cut-off valve has been developed. This cut-off

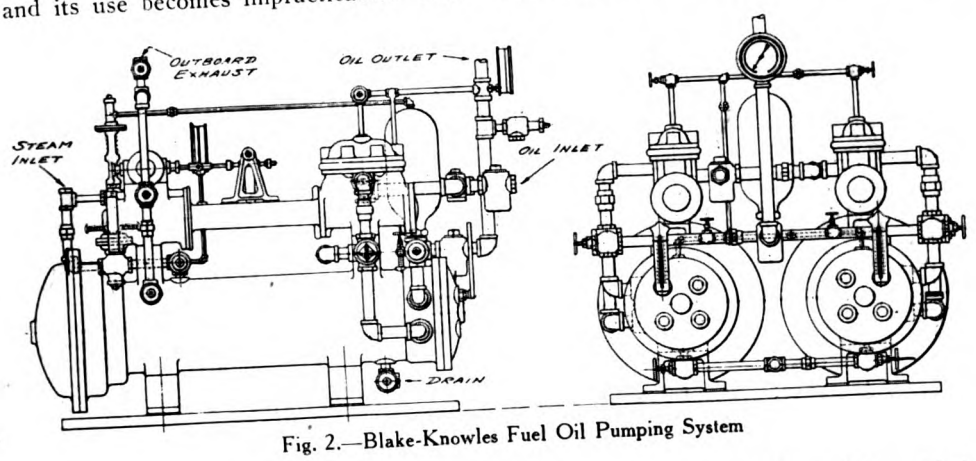

Fig. 2.—Blake-Knowles Fuel Oil Pumping System

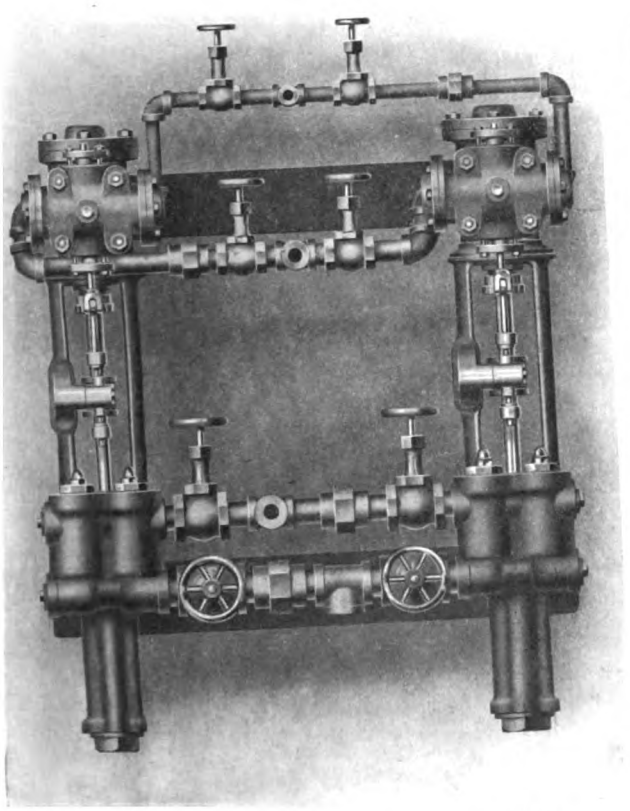

Fig. 3.—Vertical Fuel Oil Pumps (Double Units)

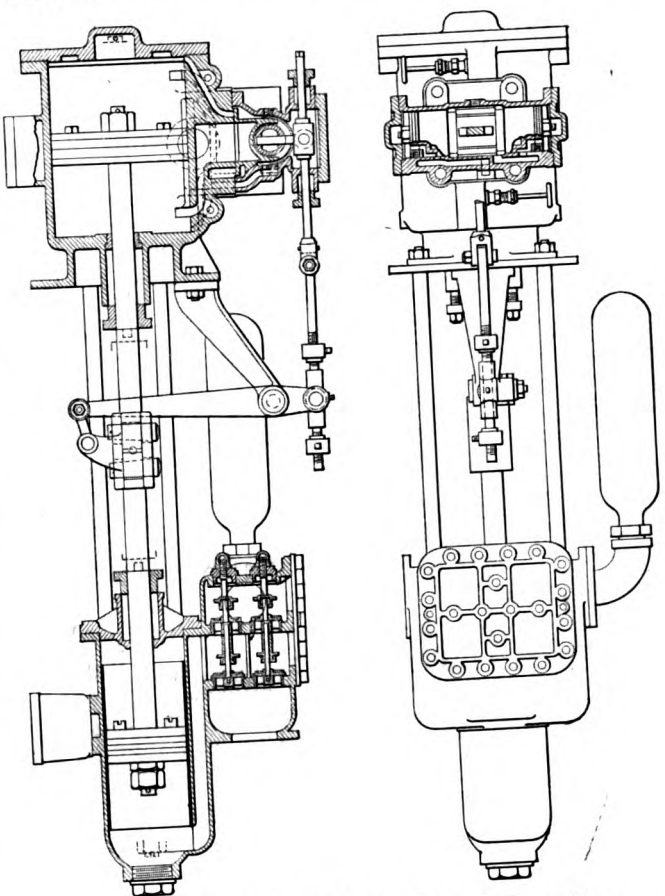

Fig. 4.—Original Design Simplex Vertical Piston Pump

The section through the steam cylinder and chest, as shown in Fig. 6, clearly illustrates how these two principles have been developed into the most up-to-date type of valve gear for single direct-acting pumps. This valve gear can be used equally well on horizontal or vertical machines. The particular advantage of a valve gear of valve, combined with the long-stroke simplex pump for feed service, is now capable of operating with a steam consumption that will compare very favorably with any turbine-driven unit operating on similar service. Each of these types of pumps has its proper place, depending upon the installation, and in some cases, particularly in

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small sizes up to capacities of 6,000 to 8,000 horsepower, the direct-acting pump is the most economical arrangement for the consumption of fuel, while in the larger sets

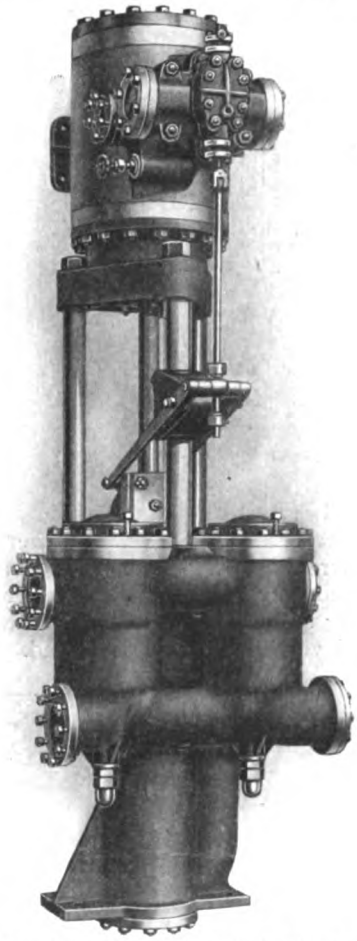


Fig. 5.—Latest Type Vertical Simplex Pump

it will be undoubtedly found, under proper working conditions, that the steam turbine set has the advantage in fuel economy.

The cut-off valve gear for vertical direct-acting pumps is in general similar to the latest styles of simplex gear referred to above, with the addition of two adjustable cut-off valves. These, like the auxiliary, operate on the back of the main valve. Instead of cushioning the reciprocating parts on the exhaust steam at the end of the stroke, as in the ordinary simplex pump, the speed of the moving parts is reduced by the decreasing steam pressure, due to the cut-off. In addition to the improved steam economy through the use of this gear the action of the pump operated on this principle is extremely smooth and quiet. The reversal is quick, but without shock to the pipe line. Should it be desired to operate the pump at any time without the cut-off action the gear may be turned back so that the cut-off valve will close the steam ports and the piston may then be cushioned in the regular manner by the proper adjustment of the cushion valves. With the use of a long-stroke simplex pump and cut-off valve

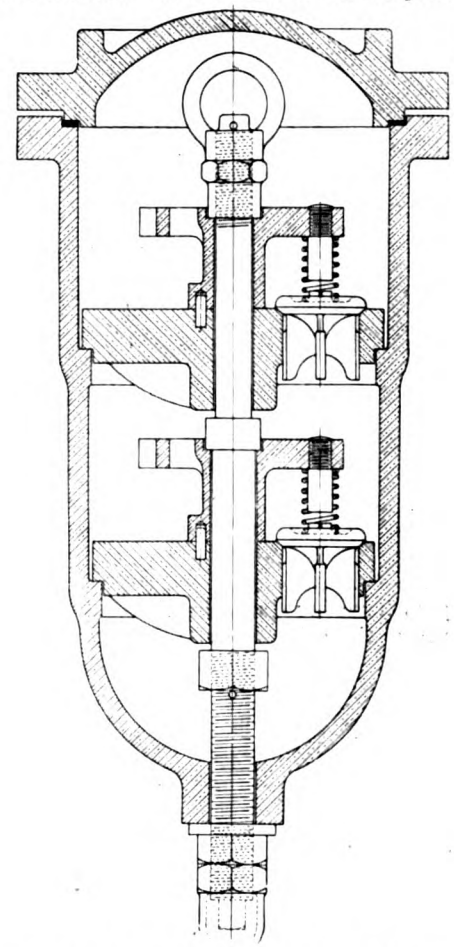
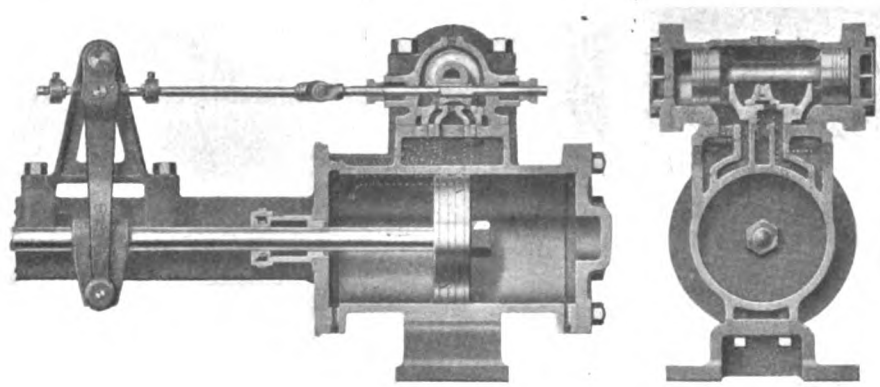


Fig. 8.—Valve Service in Water Cylinders



Figs. 6 and 7.—Sectional Views, Showing Stuctural Features of Steam end of Blake-Knowles Simplex Style "A" Pump

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gear, together with a properly-designed air chamber, all shock may be eliminated from the feed line and results similar to those obtained from centrifugal units are readily obtainable.

Water cylinders have been modified considerably. The

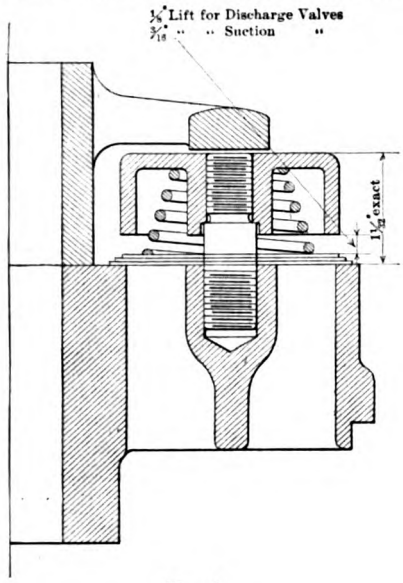

Fig. 9

tendency in most cases has been to eliminate all flat surfaces and substitute cylindrical parts to better meet the demands for the high pressures and keep within reasonable limits of weight. The most common type of pump of this kind is shown in Fig. 5, involving all the features of cylindrical surfaces.

In conjunction with the re-designing of the water cylinders various improved types of water valve service have been brought out. Fig. 8 is a typical arrangement in which the entire internal valve gear can be withdrawn by the removal of a lock nut at the bottom and cover at the top and can be as easily replaced. Bevel-faced, wing-guided valves may be used as in Fig. 8, or valves of the kinghorn or three-disk type with suitable decks substituted, similar to those shown in Fig. 9.

Another type of more recent design and particularly adapted for feed pumps and oil cargo pumps is shown in Fig. 10. This valve is of an annular double-ported type

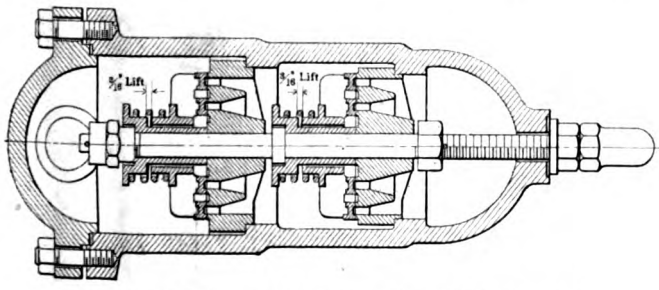

Fig. 10.—Double-ported Annular Pump Valve Service

and has the merit of a very low lift, thereby reducing the valve noise and slip to a minimum and permitting higher speed of operation.

For pumps handling cold water and with not too excessive a pressure, rubber valves may be used, but ordinarily after a comparatively short length of service it is found that the valve will show wear, due to the cutting of the valve disk by the ribs of the seat. This difficulty has been eliminated by the development of the rotating valve shown in Figs. 11 and 12. The distinctive feature of this design is the partial rotation of the valve which occurs every time it lifts from its seat, causing the point of contact between valve and seat ribs to change constantly, thus effectively distributing the wear over the

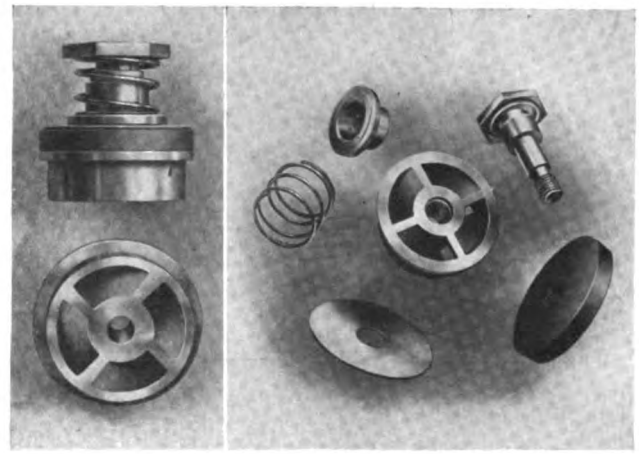

Fig. 11.—Rotating Pump Valve

Fig. 12.—Details of Rotating Pump Valve

entire valve face, which prevents scoring and accordingly prolongs the life of the valve. This action is secured by the inclining of the ribs of the valve seats so that the

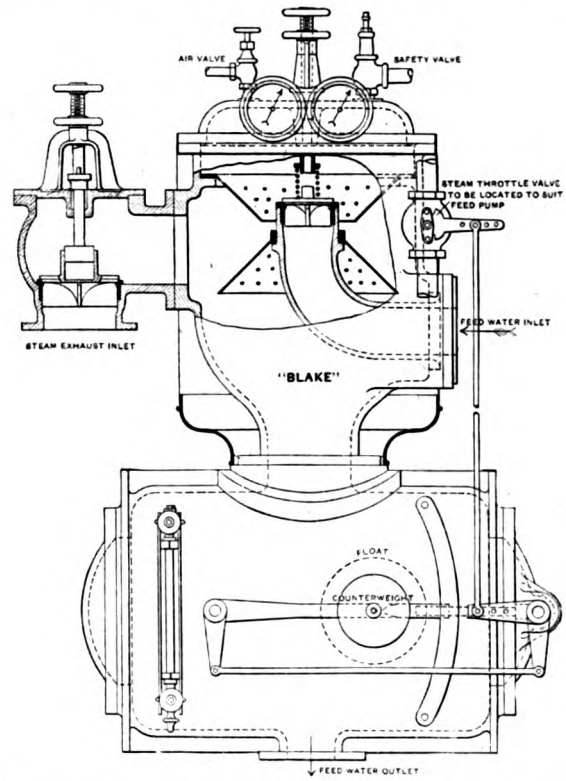

Fig. 13.—Typical Marine Feed Water Heater (Open Type)

water in passing through the seat impinges upon the valve disk at an angle. The valve is balanced by means of a hydraulic step produced by the balancing arrangement, so that the water, coming in at an angle, will cause the valve to turn.

In recent years rolled monel metal has been substituted for tobin bronze for pump piston rods and is now being extensively used for water and air cylinder linings. The material is particularly suitable for this service on account

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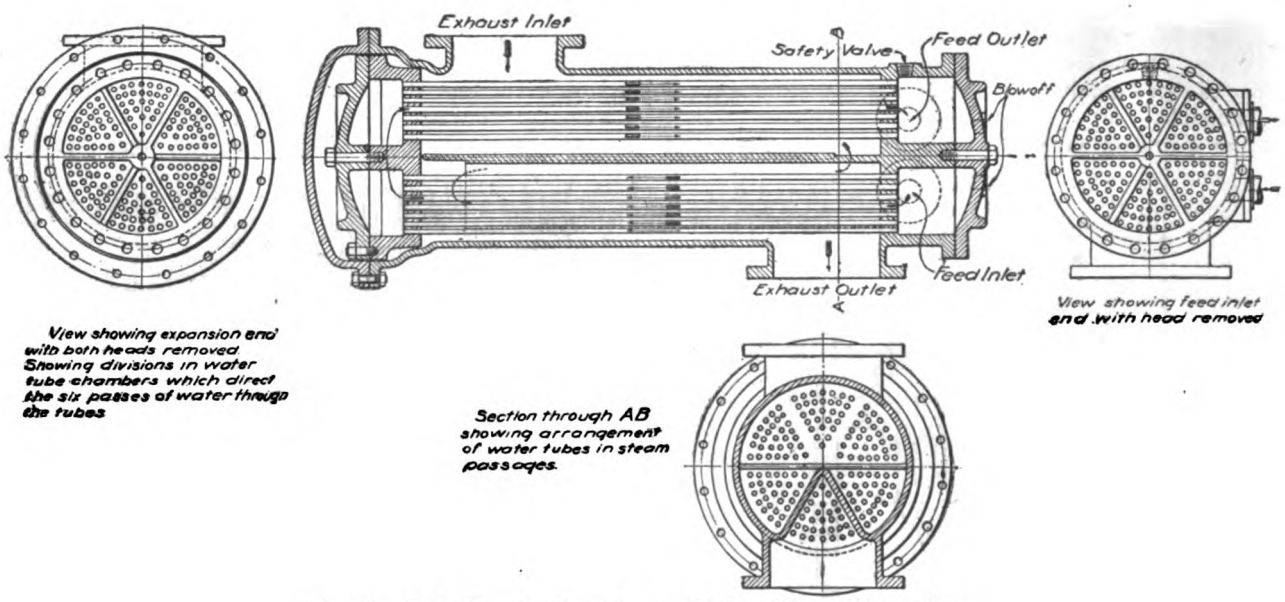
Exhaust Inlet
Safety Valve
Feed Outlet
Blowoff
Feed Inlet
Exhaust Outlet
View showing feed inlet and with head removed
View showing expansion end with both heads removed. Showing divisions in water tube chambers which direct the six passes of water through the tubes
Section through AB showing arrangement of water tubes in steam passages.

Fig. 14.—Blake-Knowles Multi-Current Horizontal Feed Water Heater

of its high tensile strength, toughness and its ability to withstand the corroding action of acid and alkali waters.

Centrifugal pumps for boiler feeding have been built in various types. The latest arrangement is a turbine-driven set and for certain conditions of installation is very well adapted to the service. Pumps of this type with the continuous flow eliminate in a great measure the pounding through the valves, piping and checks, although the same results can be accomplished by the proper use of air chambers on long-stroke vertical simplex pumps.

Heating feed water for marine installations is rapidly becoming common practice, not only for the advantage of obtaining fuel economy but also for the prevention of boiler strains, which rapidly deteriorate and reduce the life of the boiler. The heater shown in Fig. 13 shows the typical marine heater, which has met with great success in all types of vessels. Its simplicity of operation is clearly illustrated in this cut, and it is noted that it is of the open type, where the steam and water are in direct contact. Another type of common feed heater for marine installations is the multi-current horizontal or vertical types, as shown in Fig. 14. As is clearly shown in the illustration, this heater is of the six-pass type, which guarantees a maximum degree of heat in the feed water to a minimum amount of steam used. This type of heater is strongly recommended for use where the heating steam is the exhaust from auxiliaries in which lubricants have been used in the steam cylinders.

The undesirability of using salt water in boilers requires the installation of some form of evaporator and distiller for making up the feed water losses. One of the latest designs of modern evaporators is shown in Fig. 15, which, when combined with a distiller, makes an extremely economical unit. All internal parts which gather the salt

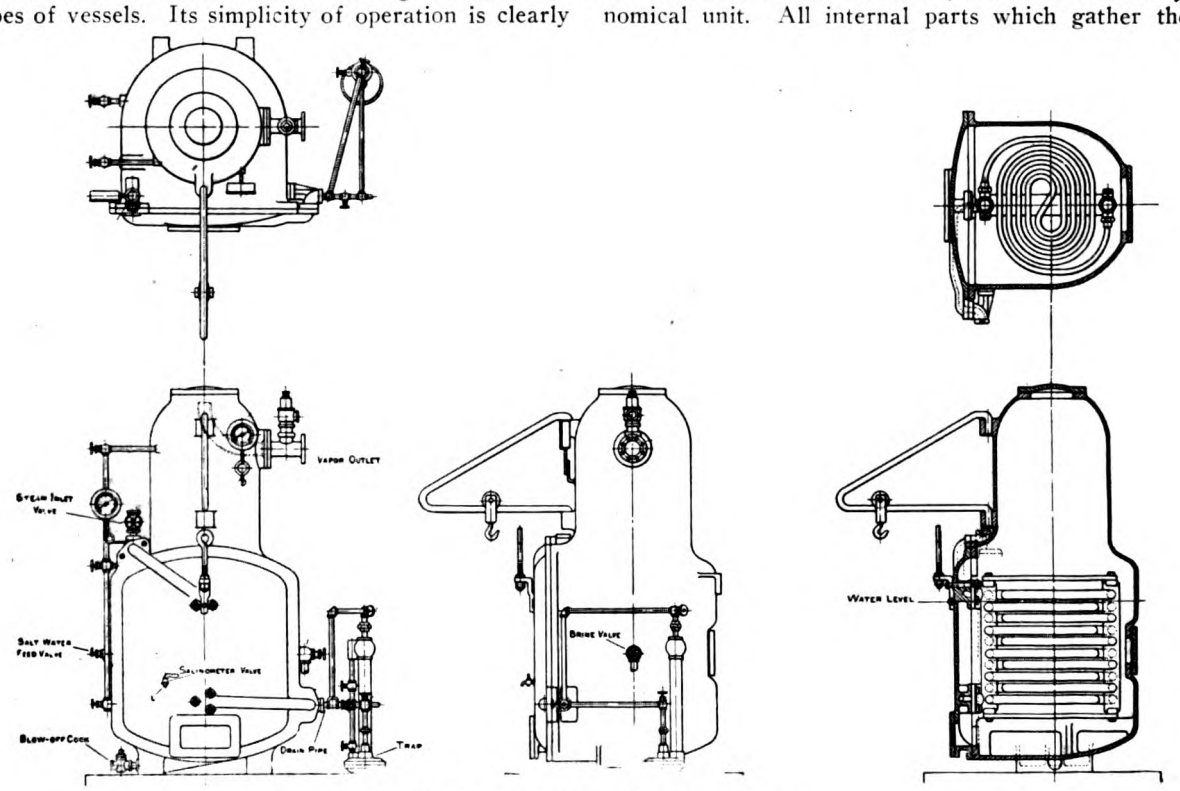

Fig. 15.—Blake-Knowles Salt-Water Evaporator

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water scale can be swung out on an arm so that easy access is offered for the proper cleaning of the tubes. The distiller is made either in the form of a two-pass condenser or, better still, by using the six-pass multi-current condenser similar to that shown in Fig. 14.

Great strides have been made in late years in the use of high-vacuum systems and the auxiliary machinery required to produce these vacua. The latest development is the wet and dry system, commonly known as the "twinplex." In form it is much like the well-known twin-beam air pump, except that one side handles water vapors only

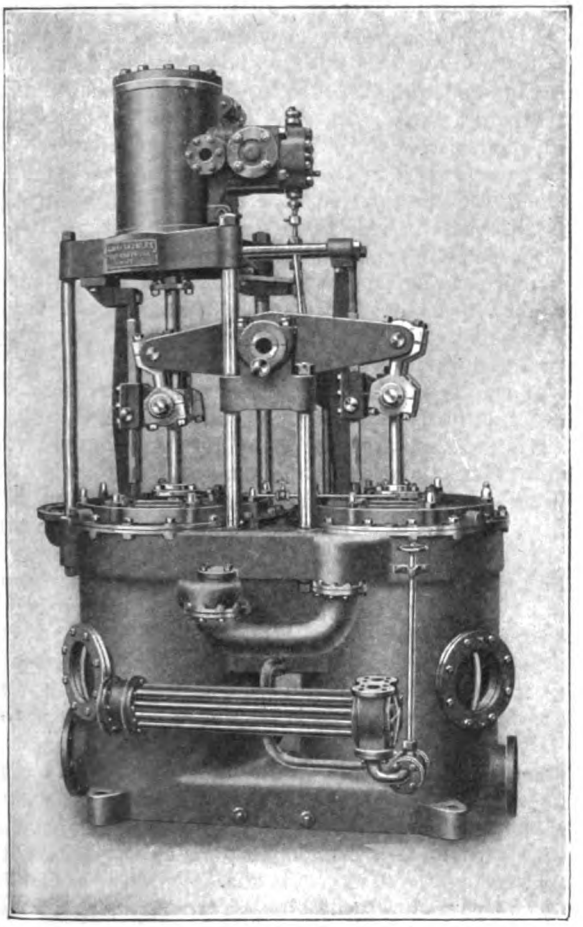

Fig. 16.—Blake-Knowles "Twinplex" Pumps for High-Vacuum Systems

and the other side takes care of all dry vapors from the condensers. The further advantage obtained by the use of the "twinplex" system is that the dry cylinder exhausts under the head valves of the wet cylinder, thus always maintaining a high vacuum in the dry cylinder clearance space and thereby making it possible to produce a higher over-all vacuum in the condenser. This type of air pumping system is equivalent to a three-stage machine and requires a condenser designed for the purpose. It also provides means for the reduction in temperature of the dry vapors and therefore their volume, which is essential to the production of the high vacuum.

Fig. 16 shows the latest type of "twinplex" pump, such as is being installed by nearly all marine high-vacuum systems, both for naval and merchant service.

Future development will undoubtedly be along the lines of greater steam economy. This may be accomplished in two places: First, by the use of vertical direct-acting, long-stroke cut-off pumps or by the use of high-speed, turbine-driven centrifugal units, each of these types having its proper place, depending upon the particular installation. Second, by the use of high vacuum systems with the proper care given to the design of the condenser and air pump units.

Marine Engineering at the Naval Academy

BY D. G. VAN DE WATER*

THE subject of marine engineering is covered more thoroughly in the four-year course at the United State Naval Academy at Annapolis than in any other institution of its kind or character in the world.

The course is under the direction of the Department of Marine Engineering and Naval Construction and the first year's work is devoted to the study of the "language of engineering," line drawing, descriptive geometry, engineering and mechanical drawing. This is followed in the second year by the assembling and disassembling parts of completed drawings. During the second term of this year the midshipmen make a thorough study of mechanical processes and have courses in shop work practice and metallurgy. A member of this class has instruction in the pattern shop and works in the foundry while he studies the forms and molds for, and makes castings of, various metals. He studies the various processes of abstracting metals from their ores and works in the blacksmith shop, machine and boiler shops, making a general study of boilers and reciprocating engines.

The first half of the third year is devoted to a thorough study of marine and naval boilers of all types, together with their fittings and accessories. The care, management and testing of boilers is part of the instruction in this term's work. During the second part of this year the midshipman is given a more detailed course in naval and reciprocating engines and auxiliary machinery, studying the theory and practice of taking indicator cards and of determining brake and shaft horsepower. He studies propulsion, especially as applied to screw propellers. The operation and management of fire and boiler rooms, with the naval regulations concerning them form part of this term's work and is followed by a practical study of internal combustion engines.

During the first half of the fourth year the midshipman's time is devoted to a study of the principles of naval architecture and their application to the construction of the types of vessels of the United States Navy. Numerous sectional models, as well as operative models of appliances and installations generally, are empoyed in this course. The second term of the final year is applied to the study of turbines, their principle and operation. Included in the laboratory equipment are extensive turbine installations providing for the practical application of the theory involved.

The Naval Academy's equipment for all this work is exceptionally fine and is housed chiefly in Isherwood Hall, a model plant, named for the renowned Engineer-in-Chief of the Navy during the period of the Civil War. In this building are models of various types of dry docks, a complete set of torpedo-boat engines, various makes of turbines and ice machines. There is an entire room devoted to internal combustion engines. Every type of auxiliary and fitting and casting used aboard ship is to be found in this building, as are also many models worked by steam and compressed air; all the different makes of boilers, ship forms and structures, and models of warships. In Isherwood Hall there are are also machine, woodworking and blacksmith shops, a foundry, an assembling room and a splendidly equipped drawing room.

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Forced Lubrication for Marine Turbines*

Combined Gravity and Forced System Designed to Meet Requirements of Single Screw Cargo-Carrying Steamers

WITH the more or less general adoption of geared turbines to all classes of ocean-going vessels, in most of which, unlike the navy, there are only two engineers on watch, it has become necessary to give the subject of lubrication considerable thought, with a view to obtaining a degree of simplicity and dependability which will reduce attention and anxiety to a minimum.

When considering the adoption of any particular system it must be borne in mind that no hitch should be possible which might in any way make it necessary to stop the turbines, otherwise, under difficult sea conditions, results might be disastrous. To meet such a condition, all important fittings which in themselves could obstruct the passage of oil must be supplied in duplicate, or be capable of being by-passed and be easy of rapid overhaul.

As every trade route has its own conditions to meet, it is impossible to describe a system suitable for every class of ship, but it is proposed to describe a system which will meet the requirements of many single screw cargo-carrying vessels, and which can be modified to meet special conditions, arising from long voyages, tropical waters, etc.

A combined gravity and forced system offers the greatest advantages, and consists simply of a pump taking oil from a drain tank and discharging it through a cooler to a gravity tank, from which it falls to the turbine bearings, etc., and back to the drain tank; or can be by-passed, in which case it does not enter the gravity tank, but is forced direct to the machinery.

The following main fittings would be required for such a system, and are stated in the order in which the oil would pass through them, when traveling from the drain tank to the turbine. One drain tank, two oil strainers (one for each pump); two pumps (one working and one stand-by); one oil cooler; two gravity tanks, and one combined oil distributor and water and sludge collector. There are many small fittings of a more or less essential character, and these will be dealt with in describing the above main fittings.

The drain tank should be of sufficient capacity, when full, to supply oil for fifteen minutes, assuming none is returning to the drain tank; or, in other words, the oil should be travelling four complete circuits in an hour. The tank should be a self-contained unit placed in a cofferdam in the double bottom rather than built into, and forming part of, the double bottom, and should be easy of removal for examination. The top should not be less than 6 inches below bottom of the gear case to ensure a ready drain, and not less than 3 inches above double bottom tank, to clear bilge water. In addition to the drain and suction pipe connections, a float level indicator must be fitted so as to be easily observed from the starting platform, also an air pipe and manhole.

The oil strainers perform an important duty and deserve attention in design. The body may be of cast iron, having a cover easy of removal, to enable inspection and cleaning of the straining grid. The grid may be a gunmetal casting or a steel tube perforated with holes, say, 1 inch diameter, and in either case the area through grid should be about ten times that of suction pipe. A suitable straining medium will be found in 24-mesh wire gauze, this to be properly secured to the grid. The gauze will reduce the effective area through grid by about half. The strainer should be in an accessible position, and have the cover on top to avoid overflow of oil when cleaning.

The pumps are made by specialists and need no particular description; however, they should be ordered of ample capacity and be fitted with a valve or cock on discharge, and suction branches for isolation purposes in case of overhaul at sea. For guidance purposes the speed of oil through discharge pipes may be taken at 200 feet per minute for pipes 3 inches diameter and above.

The oil cooler calls for special attention, particularly when the vessel passes through tropical waters. It may take the same form as a steam condenser, with similar tubes and packing, but with the water circulating around outside of tubes, with preferably a four or six flow to insure good circulation. This plan has been largely adopted, but it is economically impossible to render the flow of the oil turbulent, and the rate of heat transfer is accordingly low. Even viscous fluids, however, will not maintain the laminar character of the flow around a sharp corner. Hence certain firms construct their coolers in a different way. The water is passed through the tubes and the oil outside. Numerous baffles are fitted to cause the oil to flow up and down in zigzag fashion across the cooling tubes, and at each abrupt change of direction a certain disturbance is produced in the laminar flow of the oil, which facilitates the interchange of heat. At present knowledge of oil coolers is in its infancy, and there is much room for research and careful design. It is desirable to fit thermometer pockets on oil and water inlet and outlet. The present practice admits of oil discharging to turbines at 80 degrees F., and leaving turbines at a maximum of 120 degrees F. The cooler should be easily accessible and have a by-pass fitted.

Each gravity tank should be of equal capacity to the drain tank and be fitted with cocks to enable either tank to be in circulating use while the other acts as a settling tank. These tanks must be placed high enough to give a gravity pressure of at least 10 pounds per square inch, and should be fitted with gage glass and float indicator with wire leads and gage board arranged to enable the level to be observed from the starting platform. A manhole, air pipe and overflow pipe must be fitted, the overflow pipe being led back to the drain tank or reserve oil tanks. As previously mentioned, a by-pass is fitted between the pump and the gravity tank to enable forced lubrication to be applied to the turbines without the oil having to pass through the gravity tanks.

The combined oil lubricator and water and sludge collector need be nothing more than a cylindrical casting of sufficient depth to admit of water and sludge gathering at the bottom, while oil flows out at the top to the bearings and gear sprayers. It is desirable to fit separate connections from the distributor to the bearings and gear sprayers, with a controlling valve at each, as an adjustment is thereby easily effected whereby the bearings and sprayers will each receive their proper share of oil. A water draw-off cock placed about 12 inches from the bottom and a door for removal of sludge are to be provided.

Having covered the main fittings, a word or two on the turbine fittings might not be out of place. Control valves

* From *Engineering*.

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on each turbine bearing are unnecessary, provided the pipe arrangements are such that all bearings get an equal chance. To ensure this, pipes should have easy bends and branches on pieces be given direction with flow of oil. Means of testing the flow to bearings must be provided, and may take the form of a sight glass placed in the line of pipe, or of a test cock on the high pressure side of a bearing, having a visible flow to the drain side. As an extra precaution pressure gages may be fitted on the pressure side. The gearing sprayers should each be fitted with a guard cock having a locked-open arrangement.

The pipes and fittings should be tested to 50 pounds per square inch, with the exception of the tanks, for which a 5-pound test is sufficient. A relief valve should be provided near the pump set to blow-off at 50 pounds per square inch, having an outlet led to the pump suction. The pipes may be of steam-quality iron, with the exception of the small sizes, where it will be found cheaper and more convenient to fit copper pipes with nipples. Great care should be taken in shops to clean out turbine, gear case and other castings thoroughly. A steam jet will be found a convenient means of removing all traces of sand and other foreign matter, while linen makes a good finishing-off cloth. Cotton or other waste should not be used, as much trouble has sometimes arisen, due to the strands of thread, etc., left on the castings. It is impossible to lay too much stress on the importance of this necessity for thorough cleaning.

It will be noted that nothing has been said regarding the water circulation to the oil cooler; this can be arranged as desired, but a separate pump is undoubtedly best, with a stand-by connection from main condenser circulating pump. If this latter is fitted, a good circulation is obtained by leading the discharge from the cooler to the main circulating pump suction. Should a separate overboard valve be fitted, it must not be placed higher on the ship's side than the main circulating discharge, otherwise the heads are unequal and the cooler might suffer accordingly.

The system described is a simple one, with as few complications as possible, and can be adapted to most vessels. It has been pointed out in some quarters that particles of metal from the gearing mix with the oil and gradually work their way into the bearings, with bad effect. To avoid this, separate systems have been fitted, one to the turbine bearings, and the other to the sprayers and gearing bearings, it being necessary to combine the two latter, due to the drain being a common one into the gear case. It is very doubtful if such a partial correction is worth all the duplication of working parts necessary to carry it out, and it is also doubtful if with good quality of gearing and reasonable changes of oil any trouble may be expected from the bearings.

Marine Lubrication—Twenty Years' Progress

Animal or Vegetable Oils Superseded by Combination with Mineral Oils—Forced or Positive Feed Now Supplanting Wick Oiling

BY W. F. PARISH

BEFORE the advent of mineral oils marine engines were lubricated with sperm oil or whale oil, or by a vegetable oil such as rapeseed or olive oil, and in some cases with lard oil. Many of the marine engineers to-day tell stories of the great satisfaction that they had twenty years or so ago, when the above-mentioned materials were used, and they seem to regret very much that the prices of these oils make them commercially impossible as lubricants for this very extensive class of service.

We know to-day that these animal or vegetable oils have certain fundamental defects when used for the lubrication of machinery. Invariably, due to heat generated in the bearings and to oxidation, these oils will throw out a free, fatty acid which attacks the metal, causing pitting and corrosion, which, however, is never very much in evidence while the same character of oil is being used.

The gradual increase in price of these oils, due to their constantly decreasing production, made it necessary to look for other material. At first mineral oils were combined with various proportions, generally very large, of some of the animal or vegetable oils. There is a rather peculiar, well-grounded condition in regard to marine lubrication that does not exist in the lubrication of any other class of machinery; that is, the oil used must saponify when working with water. All of the animal and vegetable oils formerly used would form soaps on the guides and in the bearings when worked with water, and it was considered absolutely necessary to have oil that would act in this manner on any bearing or guide when water was turned on it, the reason being, supposedly, that soap would not wash from the surfaces as readily as straight mineral oil. The fact that it seems to be necessary to have an oil that will in some manner form an emulsion if water is used has established the present practice of making marine oils on the basis of a mineral stock compounded with from 10 percent to 25 percent of vegetable or animal oil.

The use of these compounded oils, outside of Government and special service, has not undergone any very great change since the marine practice was first developed. Old wick oilers are still in use, and hand oiling is resorted to as the main feature of lubrication on some vessels, the wick oilers having been taken off entirely on other ships or being depended upon only as auxiliaries. When the time comes in the future for changing over the lubrication of all marine engines to a forced or positive feed system it will then be possible to furnish oils that will be much better lubricants than those now in general use and that can be used with greater economy and with less danger to the operating machinery.

Wick oiling, while still depended upon to a large extent in marine work, is, as a matter of fact, a very unstable and unscientific method, developed largely by the rule of thumb and not subject to any fixed rule. Each wick seems to be an individual unit that varies in its feed according to many conditions not at present well understood. For instance, it is supposed that increasing the number of wicks will increase the amount fed and decreasing the number of wicks will decrease the amount fed. Very careful tests, however, made on a number of ships have

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shown that the flow of oil through wick oilers does not conform to this rule, and that under fixed conditions as to height of oil in the manifold, number of strands, and temperature of the oil and the room, plus and minus results are secured without any apparent reason.

Progress in Marine Lubrication

BY D. S. PATERSON*

During the past twenty years rapid strides have been made towards a more efficient lubrication of marine machinery. Lubricating oil has been more generally used owing to its nature being such as to be able to lubricate with a force feed system, and owing to the inability of procuring a grease of such quality and durability as would accomplish the work.

In times past the greases used in the lubrication of marine machinery have been of the common tallow kind, which could not give satisfactory results through inability to stand up under medium temperatures and pressures. As is well known, tallow greases will become rancid by age, owing to the constituent parts breaking up by coming in contact with the moisture and oxygen of the atmosphere. Not only do they become rancid, they also contain acids which corrode and pit journals and bearings. Again, tallow greases will not stand up under the action of water when brought in contact with it. Principally due to these reasons, therefore, the use of grease for marine lubrication has not been so extensive as demanded by the absolute requirements with a grease of the proper quality.

At the present time high-grade petroleum greases are superseding tallow greases for marine lubrication and are rapidly becoming popular because of their superior lubricating qualities. High-grade petroleum grease will hold its viscosity under high temperatures, will not decompose when brought into contact with the atmosphere, water or steam; neither will it deteriorate with age. It can be taken into any climate and it will maintain its original density without loss of lubricating efficiency.

On the other hand, tallow greases, the same as oil, will shirk their work. They flow off the bearings as soon as applied, while high-grade petroleum grease has sufficient adhesive and cohesive properties to remain on the bearings until it is thoroughly used up. Tallow greases under medium bearing pressures have at least 20 percent greater friction load than high-grade petroleum grease. At double the pressure, tallow grease has 107 percent higher friction "load" than high-grade petroleum grease.

The need of a heavier than oil lubricant, which would eliminate the weaknesses of the tallow greases, resulted in the production of lubricating greases, many of which were originally (and still are) but little more than soft soap, with a weight-making and non-lubricating "filler" to give them body. The nature of this "filler" varies, according to the theory of the maker. It may be wax, paraffine, resin, resinous oil, talc, clay, graphite or some other substance, equally worthless as a lubricant; and in most cases positively injurious to the bearings to which it is applied. Not one of these materials will add in the slightest degree to the lubricating efficiency; but, on the contrary, will materially increase the friction load on every bearing on which such a lubricant may be used. Many greases are made wholly or partly from animal oils, which decompose or become rancid, and may be very offensive when kept in a hot engine room. Such greases are generally highly scented to disguise the odor arising from this cause. Oil of myrbane, which smells like almond oil, and oil of citronella are extensively used for this purpose. The failure of such mixtures to give efficient lubrication, and their tendency to increase rather than decrease bearing troubles, has naturally prejudiced many engineers against the use of grease, but since the introduction of high-grade petroleum grease its superior efficiency under all working conditions the year round has been so thoroughly demonstrated that it is generally recognized by consulting and practical engineers as the ideal lubricant for practically all purposes.

The true value of a lubricant lies not only in its capacity for reducing the friction load under moderate and low-bearing pressure, but it is especially valuable and economical when it is capable of developing a low coefficient of friction under severe loads as well. This is especially evident where bearings are burdened with heavier loads than they are usually compelled to carry. It is always poor policy to let "well enough" alone. When there is a tendency for a few bearings to run warm, every effort should be expended to prevent the development of the excessive friction which they are surely carrying. A friction reduction of even a slight percentage through the use of a high-grade petroleum grease will offset the extra cost of the lubricant many times over the decreased fuel consumption.

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Large Fleet of Light Draft Motorboats for Coast Defense Recommended by Naval Consulting Board

The Naval Consulting Board held its annual meeting in New York city on March 10, and at the conclusion of the session issued the following statement: "The Naval Consulting Board wish to say that there is no truth whatever in the report circulated that Mr. Thomas A. Edison has resigned from the board. He was to-day unanimously elected president of the board for life. There was a large attendance, nearly all the members being present. A new committee on metallurgy was appointed with Professor Richards, of Lehigh University, at its head. The subject of submarines received a great deal of attention. Reports were made on methods of improvement of torpedoes and on the development of internal combustion motors, and Hudson Maxim made a report on improvement in methods of constructing large guns. Certain recommendations for important experiments relating thereto were approved. Important reports were made on developing new methods of detecting and locating submarines and defending vessels against torpedo attacks."

The following resolution was adopted by the board: "The Naval Consulting Board at its meeting held in New York on March 10, 1917, is unanimously of the opinion that a large fleet of light draft high speed motorboats, built preferably of wood, because of the opportunity which it gives for quick construction and carrying guns, should be provided at the earliest possible moment for the protection of the coasts and harbors of the United States and vessels traveling thereon."

The board recommended on the report made by Mr. Sprague that the Navy make an investigation and trial of a new type of light mosquito craft. The Secretary of the Navy is co-operating with the board in facilitating the carrying on of certain special experimental work involved in national defence. The Commission of Special Problems has started to make experiments on under water detection by electric, magnetic and electromagnetic means.

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Development of American Coastwise Ships

General Characteristics of Coastwise Passenger and Freight Steamers—Application of the Steam Turbine to Express Steamers

THE first American coastwise steamship to be described in MARINE ENGINEERING was the passenger and freight steamer *Princess Anne,* built just twenty years ago at the old Roach shipyard in Chester, Pa., for the New York-Norfolk service of the Old Dominion Steamship Company. The *Princess Anne* was 326 feet 5 inches long by 42 feet beam and 27 feet molded depth. Her gross tonnage was 3,078 and she had a cargo capacity of 150,000 cubic feet on a load draft of 17 feet. Propulsion was by a triple expansion reciprocating engine of 3,500 horsepower designed to give the ship a speed of 16 knots. Steam was supplied at a pressure of 190 pounds per square inch by four single-ended Scotch boilers placed athwartships with a fore and aft fireroom on the centerline of the vessel. Although other vessels have been added to the Old Dominion fleet during the past twenty years, it is significant that generally speaking, with the exception of accommodations and equipment, practically no changes have been made in the design of either the hull or propelling machinery adopted at that time. The regularity of service and economy of operation maintained year in and year out by the vessels of this fleet give some indication of the high standard early attained by ship designers and builders in this country in the construction of a distinctly American type of coastwise steamship.

REPRESENTATIVE TYPES OF VESSELS

Disregarding vessels of special types for bay, sound and river service, the ships which form the regular American coastwise fleets may be divided into two classes—passenger and cargo steamers and freighters. Except in the case of vessels operated by or in competition with the railroads, the speed of American coastwise passenger vessels has not exceeded 16 knots, while the average speed of the purely freight steamers is from 10 to 12 knots. Most of the vessels have been of the single screw type driven by triple or quadruple expansion reciprocating engines supplied with steam at from 160 to 215 pounds pressure by Scotch boilers operating under natural draft.

Except for the recent introduction of longitudinal framing there have been no radical developments in the hull construction of vessels of this type other than the continual evolution of improved forms of hulls in accordance with the principles established by model tank experiments and the gradual introduction of improvements designed to safeguard the navigation of the vessels. While the nature of the service in most of the coastwise lines is such as to limit any radical development in the size, power and speed of the ships, nevertheless as far as passenger accommodations and equipment are concerned full advantage has been taken of the latest developments to provide every modern convenience and luxury and safeguard for the traveler at sea.

In the case of cargo boats there is a general tendency toward increase of size and capacity and a steady improvement in economy and efficiency of operation. A noteworthy example of vessels of this class is the fleet of the American Hawaiian Steamship Company. This company now operates twenty ships, sixteen of which are oil burning and four coal burning steamers. Among the largest of these are those of the *Kentuckian* class, built in 1912 and 1913 by the Maryland Steel Company, Sparrows Point, Md. They are 416 feet 2 inches long between perpendiculars, 53 feet 6 inches beam and 31 feet 6 inches molded depth, with a gross tonnage of 6,660, a net tonnage of 4,111 and a deadweight carrying capacity of 10,200 tons at a draft of 29 feet 6½ inches. Propulsion is by a quadruple expansion engine of 4,000 horsepower supplied with steam at 215 pounds pressure by three single-ended boilers operated under forced draft.

TURBINE-DRIVEN SHIPS

The first American coastwise steamer to be fitted with turbine propelling machinery was the *Governor Cobb,* a 300-foot vessel of 2,184 tons and 5,000 horsepower built in 1906 by the W. & A. Fletcher Company, Hoboken, N. J., for the Eastern Steamship Company, of Boston, Mass. This vessel was fitted with a three-shaft arrangement of Parsons turbines and Scotch boilers operating under forced draft. In the same year a larger vessel, the *Creole* of the Southern Pacific Company, was built by the Fore River Shipbuilding Company, Quincy, Mass., and fitted with Curtis turbines and Babcock & Wilcox watertube boilers. The *Creole* was a twin screw vessel 440 feet long over all, of 6,754 gross tons. The turbines were designed to develop a total of 8,000 horsepower, but after a limited period of service they were replaced by triple expansion reciprocating engines.

In the following year the triple screw turbine-driven express steamers *Harvard* and *Yale* were built by the W. & A. Fletcher Company for the Metropolitan Steamship Company for night service between Boston and New York. The vessels were 386 feet 6 inches long between perpendiculars and were designed for a speed of 23 statute miles per hour. Propulsion was by Parsons turbines of 10,000 horsepower supplied with steam by 12 single-ended Scotch boilers operated under forced draft.

The largest and speediest turbine-driven vessels ever built for American coastwise service, however, were the *Great Northern* and *Northern Pacific,* built in 1914 by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the Spokane, Portland & Seattle Railway Company for service between Astoria, Ore., and San Francisco, Cal. These ships were 23-knot, triple screw passenger and freight steamers 524 feet long over all, of 8,255 gross tons and 25,000 shaft horsepower each. Steam was supplied by twelve Babcock & Wilcox watertube boilers at 220 pounds per square inch pressure, the boilers operating under forced draft.

ADVENT OF GEARED TURBINES

The rather limited application of steam turbines to coastwise vessels was due, of course, to the fact that the direct turbine drive was not adaptable to the relatively low speeds of the majority of these ships. With the recent perfection of the geared turbine, however, it is very probable that turbines will be adopted in a greater number of these vessels. The first large passenger and freight steamship equipped with machinery of this type is now being completed on the Pacific Coast, and details of this machinery, which is designed to develop 10,000 horsepower, will be found in this issue. Notwithstanding the apparent conservatism of American coastwise steamship owners in accepting new developments in marine engineering, it would be difficult to find in any other service more satisfactory records of economy and efficiency than are being made every day by American coastwise steamers.

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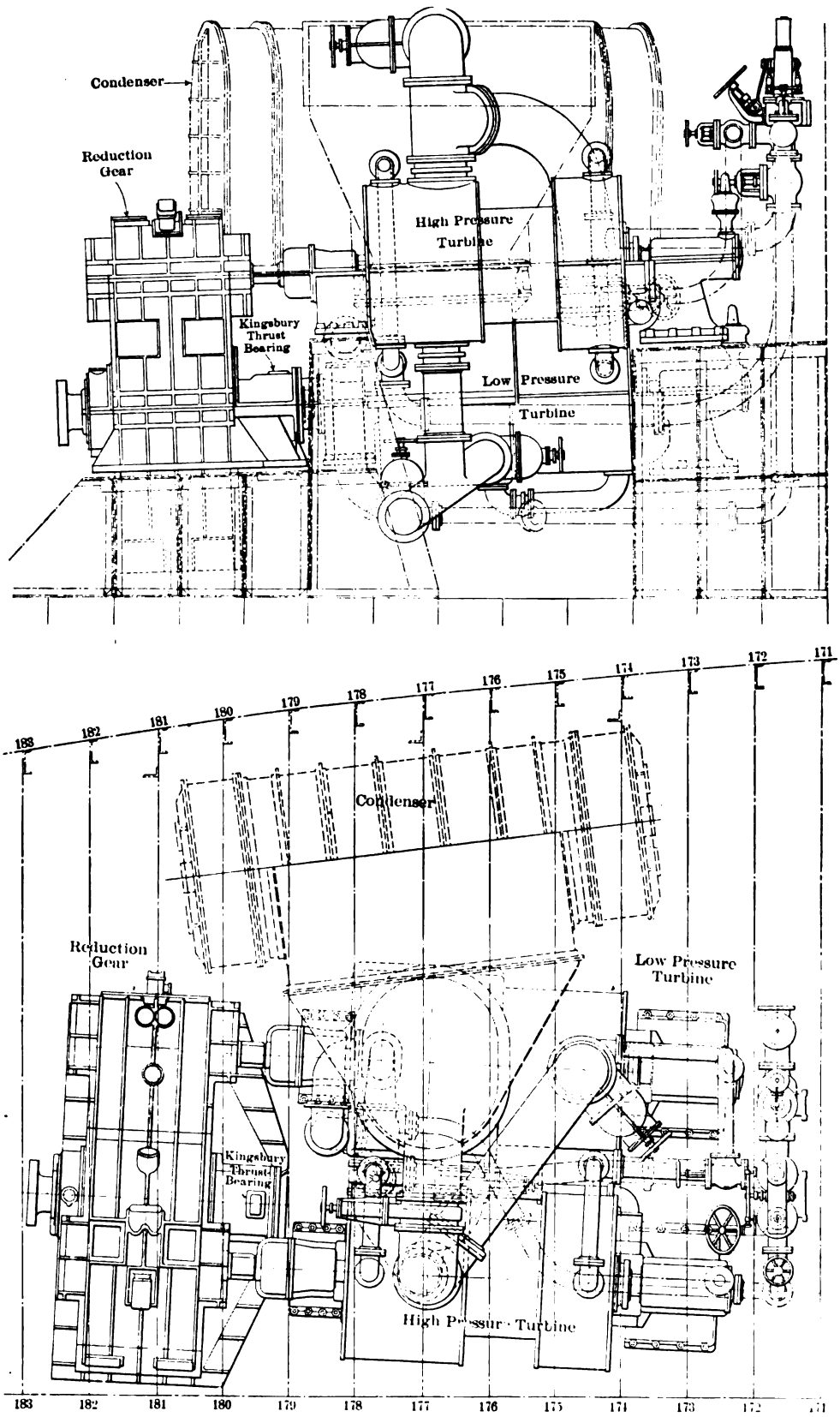
GEARED TURBINE PASSENGER STEAMSHIP MAUI

Built by Union Iron Works Company, San Francisco, Cal.



Figs. 1 and 2.—Elevation and Plan of Port Propelling Machinery

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Geared Turbine Passenger Steamship Maui

Built by Union Iron Works Company of San Francisco for Hawaiian Service of Matson Navigation Company

WHEN the steamship *Maui*, now under construction at the Union Iron Works, San Francisco, Cal., for the Matson Navigation Company, steams out of the Golden Gate she will be the first large passenger steamship to be propelled by geared turbine machinery. A number of single-screw vessels of upward of 3,000 horsepower have used this equipment, but the *Maui* is twin-screw and is rated at 10,000 horsepower. She is designed for passenger and freight service between San Francisco and the Hawaiian Islands and is scheduled to make the 2,080-mile run in 5.8 days. Her length overall is 501 feet; beam, molded, 58 feet, and load draft, 29 feet 11 inches.

The arrangement of her propelling machinery is shown in the plan, Fig. 2, which shows one of the twin units. For each propeller there are two Westinghouse turbines, high pressure and low pressure, which drive the propeller through reduction gears. Each of the two turbines consists of one ahead and one astern turbine, which are mounted on the same shaft and enclosed in a single frame. A study of the plan, Fig. 2, will make this arrangement clear and also show the course taken by the steam through the high and low-pressure turbines while running either ahead or astern. At full power each of the ahead turbines is designed to develop 2,500 horsepower at 2,070 revolutions per minute, so that the total power is 10,000 horsepower. With the same flow of steam the astern turbines will develop 6,000 horsepower.

In order to permit economical operation at reduced power the ahead nozzle chamber is divided into three compartments, two of which are provided with hand-operated valves so that when desired one-sixth or one-quarter of the nozzles can be closed off. The astern nozzles are not arranged in this manner because economy at reduced astern power is of little importance.

The types of these four turbines are as follows:

Turbine	*Type*
High pressure ahead	Impulse reaction
Low pressure ahead	Reaction
High pressure astern	Impulse
Low pressure astern	Impulse

As shown in Fig. 2, in addition to the normal cross compound operation of either the ahead or astern turbines, the steam piping and valves are so arranged that any one of the four turbines can be operated alone in case of emergency. An emergency overspeed governor is geared to each turbine shaft and controls the governor valve in the main steam line by means of a steam relay.

The machinery weights are as follows:

Turbines, with cross-connecting piping and valves	57.5 tons
Reduction gears and thrust bearings	78.0 tons
Condensers and auxiliaries	10.82 tons
Total	146.32 tons
Total weight per shaft horsepower	32.8 pounds

The Turbines

The ahead high-pressure turbine consists of a two-row impulse wheel followed by reaction blading on a drum, while the ahead low-pressure turbine is of the reaction type. The astern high and low-pressure turbines both consist of two-row impulse wheels.

The turbine casings are of cast iron, except the ahead end of the high-pressure turbine casing, which is of cast steel, and the casings are all divided on a horizontal plane.

The turbine rotors and shafts are of cast steel, the impulse wheels being formed integral with the shafts. The impulse blades are of machined nickel steel secured in the rotor by a tongue and groove construction. Vibration of the blades is prevented by the use of tight wedges. The reaction blades are of drawn phosphor bronze secured into

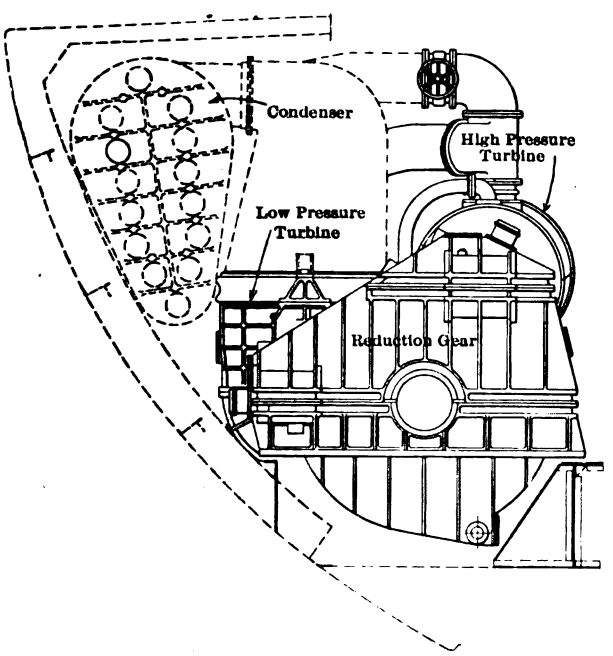

Fig. 3.—Section at Frame 183, Looking Forward

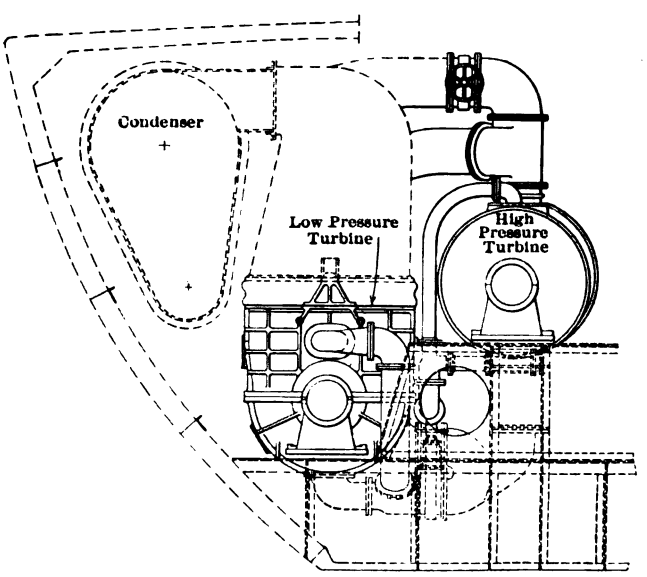

Fig. 4.—Section at Frame 179, Looking Forward

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GEARED TURBINE PASSENGER STEAMSHIP MAUI

Built by Union Iron Works Company, San Francisco, Cal.

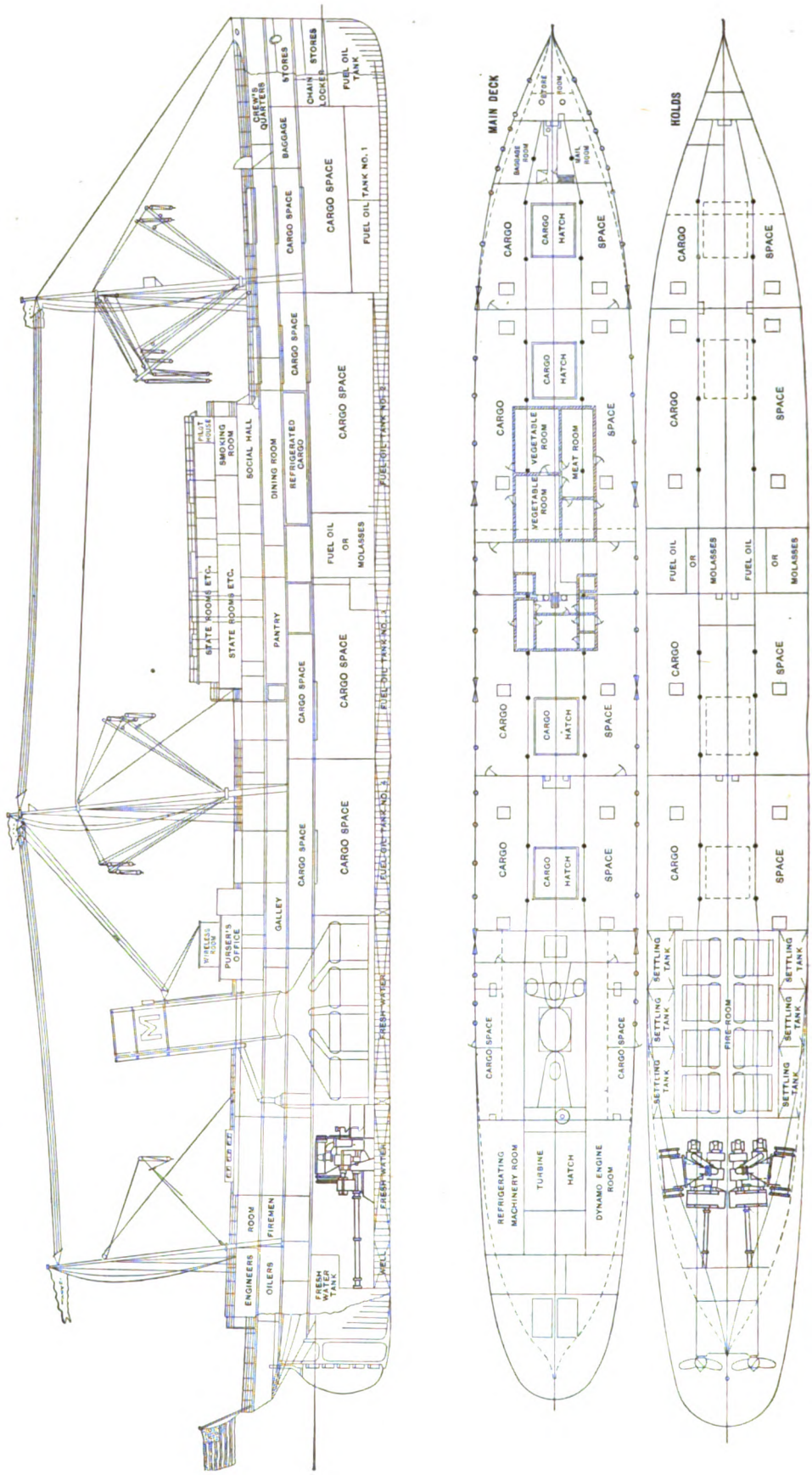

Fig. 5.—Profile and Plans of Main Deck and Holds

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GEARED TURBINE PASSENGER STEAMSHIP MAUI

Built by Union Iron Works Company, San Francisco, Cal.

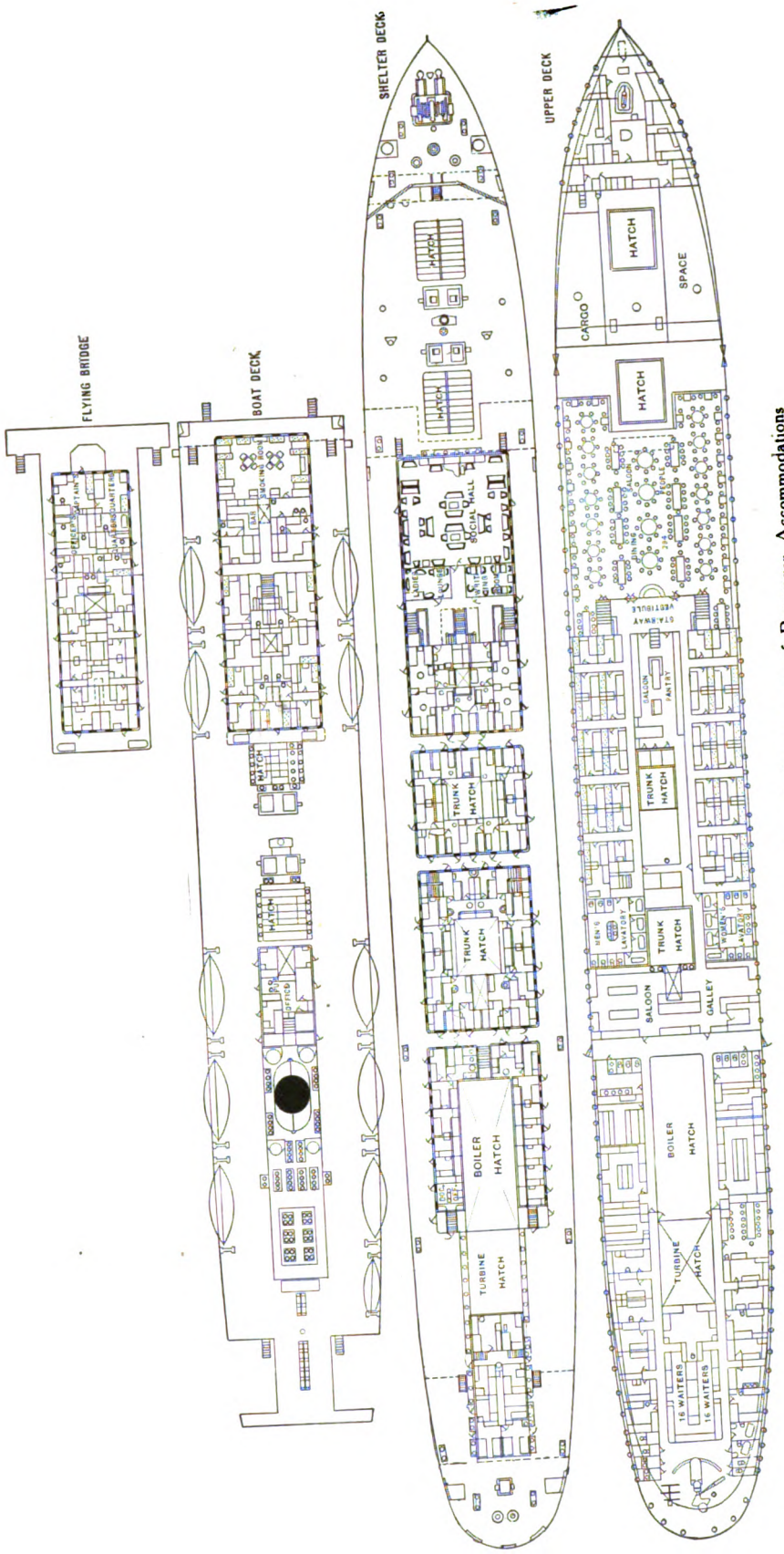

Fig. 6.—Deck Plans, Showing General Arrangement of Passenger Accommodations

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dovetail grooves by a positive mechanical interlock between blades, packing pieces and grooves.

In order partially to balance the steam thrust on the drums balance pistons are located at the inlet ends of the high and low-pressure turbines, pipes connecting the spaces behind the dummies with the exhaust from corresponding reaction blading. Between the high-pressure ahead and astern turbines packing of the radial labyrinth type is interposed. In addition to the labyrinth packing the turbine glands are further provided with steam and water seals. The water seal operates on the principle of a centrifugal pump and is designed for use only when the turbine is running from half to full speed; below half speed the centrifugal force is not sufficient to maintain the seal, and therefore from stop to half speed it is necessary to use the steam-sealed labyrinth. Steam is supplied to the glands from the main steam line through a reducing valve which regulates the pressure to about 5 pounds gage. Water is supplied to the glands from a gravity tank, located about 12 feet above the glands, into which the discharge of the condensate pump is led before passing to the feed tank.

The main bearings are of the self-alining type and are provided with pads and liners by means of which the rotors can be adjusted vertically and horizontally. Oil is supplied through the bottom pad and is led up to a distributing groove in the top of the bearing.

The portions of the turbine casings subject to high temperatures are lagged with non-conducting material and the center part of the casing is inclosed in a 1/16-inch sheet metal jacket, which is arranged for removal to give access to the casing joints. All pockets in the turbines and piping are provided with drains which are led into a steam ejector which discharges the water into the condenser, as the latter is located above the drain level. Relief valves are located on the ahead and astern receiver pipes. All pipe connections to the turbines are designed to allow free expansion without imposing stress on the turbine casings. The turbine rotors are tested to 20 percent above the designed full speed, or to 2,400 revolutions per minute.

The turning gear consists of an electric motor, connected to the turbine rotor by means of worm gearing. For lifting the turbine casings and rotors I-beam girders and chain hoists are installed above the turbines and reduction gears, together with special slings and guides for lifting the rotors without injury to the blading.

Turbine Valve Gear and Steam Piping

Admission of steam to the ahead and astern turbines is controlled by two balanced throttle valves, both of which are contained in one body and operated by the same hand wheel. The piping and valves are arranged so that, in addition to the normal cross-compound operation, either the high-pressure or the low-pressure ahead or astern turbines can be operated independently in case of emergency, the turbines being controlled by the main throttle valves in all cases.

The governor valve is of double disk balanced type, operated by two steam relay pistons. The operation of either the high or low-pressure turbine governor will cause the valve to close in case the turbine overspeeds. With this arrangement the turbine is not shut down completely and is always under direct control of the maneuvering valves.

The ahead and astern maneuvering valves are contained in a single cast steel body and are of the balanced single-disk type, with a pilot valve and the valve stem for automatically equalizing the pressure in opening. Springs are provided above the valves to prevent them from chattering in the rush of steam. Both valves are operated by a single hand-wheel and yoke.

Reduction Gears

The purpose of the reduction gears, which are of the Westinghouse double-helical type, is to permit the driving of the low-speed propeller by means of high-speed turbines. They provide a ratio of 15.95 to 1, so that at the designed full speed of 16.5 knots the turbines run at 2,070 revolutions per minute and the propeller at 129.5 revolutions per minute.

Each gear has two pinions, one from the high pressure and one from the low-pressure turbine; and each pinion transmits 2,500 horsepower, so that the total horsepower delivered to each propeller is 5,000 horsepower. Each pinion is carried in a floating frame and is driven by a flexible shaft connected to the turbine shaft by a pin-coupling that permits the pinion to move endwise. Perfect alinement between pinion and gear and uniform distribution of tooth pressure are therefore automatically maintained under all conditions of load.

Incorporated on each of the floating pinion frames is a hydraulic dynamometer by means of which the power transmitted by the pinion can be accurately measured. The pinion journal acts as a pump, and when revolving at full speed supplies a considerable flow of oil under high pressure. Normally the pinion frame is bolted securely to the gear box, but when it is desired to measure the power the bolts can be loosened sufficiently to permit the frame to float on this oil. The gage pressure of the oil under these conditions represents a pressure on the pinion teeth plus the weight of the pinion and its frame. Deducting this weight and multiplying the corrected oil pressure by the pitch line speed and a constant, the total power transmitted by the pinion is obtained. The sum of the power transmitted by all four pinions gives the total power developed, which is a value of great importance in checking the performance of the ship.

Kingsbury Thrust Bearings

The thrust of the propeller is taken by a Kingsbury thrust bearing which is carried in the gear box. This bearing consists of a ring which operates between segmental slippers, made of cast steel and lined with babbitt. Each slipper is pivoted on a hardened seat so that it automatically adjusts itself to distribute the load uniformly over the entire bearing surface. This uniform distribution of the load gives perfect film lubrication and permits the use of a considerably higher unit pressure than is possible in ordinary thrust bearings.

Lubricating System

The lubrication of the main turbine bearings, the gear teeth and bearings is effected by a continuous circulation of oil through a gravity system composed of delivery and return piping, pump, coolers and filter tank. Oil is supplied to the bearings and teeth under a pressure of about 5 pounds from a gravity tank. The oil first passes through a cooler and is then supplied to the bearings and gear teeth, after which it drains back into the drain tank. From the latter it passes into the oil pumps, which discharge it back into the gravity tank through strainers located in the top of the tank.

Boilers

The *Maui* will have eight Babcock & Wilcox marine-type watertube boilers with superheaters and will burn fuel oil. The boiler pressure will be 225 pounds gage and the superheat 50 degrees F.

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The boilers have a heating surface of 30,100 square feet and a superheating surface of 3,520 square feet. The fuel oil burning system is of the mechanical atomizing type.

Condensing Plant

The condensing plant consists of a steel plate condenser with a geared turbine-driven centrifugal circulating pump, a turbine-driven centrifugal hot-well pump and two LeBlanc air rejectors for each main unit. The vacuum produced with cooling water at 70 degrees F. will be 28.5 inches referred to a 30-inch barometer.

The condenser is arranged for three passes of cooling water. The condenser heads are of cast iron, the tubes are ⅝-inch outside diameter and are 12 feet long between tube plates, the cooling surface for each condenser being 8,000 square feet.

The main circulating pump is of the single runner slow-speed type as designed for high efficiency, and is driven by a geared turbine unit, the revolutions of the pump being 390 and of the turbine 5,836. These speeds give a high efficiency for both pump and turbine, which results in a very economical unit. Each pump has a capacity of 9,200 gallons per minute and requires 105 horsepower. The pump has a cast iron body and a double-inlet bronze runner. The glands are packed with flax packing and are provided with water seals to prevent air leakage. The rotor is carried between two bearings, one on the gear and the other on the pump body.

The gear is of the double helical type enclosed in a cast iron box. A centrifugal governor which regulates the speed of the turbine is driven from the gear shaft by spiral gears.

The turbine is composed of a high-speed impulse wheel with a single row of blades through which the steam passes twice. The shaft is provided with water-sealed glands where it passes through the casing. At full speed the speed of the turbine is regulated by the governor, which operates a balanced valve, but lower speeds are obtained by hand throttling.

The turbine bearings and reduction gear are supplied with a continuous circulation of oil from the main lubricating system, the gear teeth being lubricated by sprays.

There is a condensate or hot-well pump for withdrawing the condensate from each condenser. The pumps are of the centrifugal type and are direct turbine-driven. They are located below the condensers so that the condensate will drain into them by gravity. The condensate is discharged up into a small tank from which is taken the gland sealing water, thence it overflows into the air-ejector tank, and from there passes into the feed tank. The revolutions per minute are 2,500.

The pump is of bronze and is of the single inlet type, with a water-sealed gland to prevent air leakage.

The turbine is of the impulse type with a single row of blades, through which the steam passes twice. The casing is split horizontally and lagged and fitted with labyrinth-type glands. The rotor is carried in two ring-oiled bearings. The speed is regulated by a centrifugal governor, mounted on the turbine shaft, which operates a balanced throttle valve.

Westinghouse-LeBlanc air injectors are provided for withdrawing air from the condenser. For each condenser there are two ejectors, one being sufficient for full-load requirements and the other being provided as a spare. The air is withdrawn by multiple jets of steam in series which compress the air to atmospheric pressure. The mixture of air and steam then passes into the air-ejector tank, where the steam is condensed and the air escapes to the atmosphere. The air ejectors are made of bronze, and the tank of cast iron.

Auxiliaries

The auxiliaries include a Reilly evaporating plant of 25 tons per day capacity, three 10-ton Brunswick refrigerating machines, two 30-kilowatt and one 50-kilowatt electric generators which supply direct current at 110 volts, a Hyde anchor windlass, a Brown steering gear and nine steam cargo winches, together with the usual equipment of pumps and small auxiliaries.

The Pneumercator

The Pneumercator is an instrument of precision, which, installed in a ship, indicates the fore and aft drafts and registers the mean draft and corresponding tons displaced. It weighs cargoes and bunkers, and other models indicate the level of liquid in and the weight or volume of the same in any tank—afloat or ashore. Both types of instrument are practically foolproof, as there are no floats, diaphragms, electrical connections or other delicate parts to

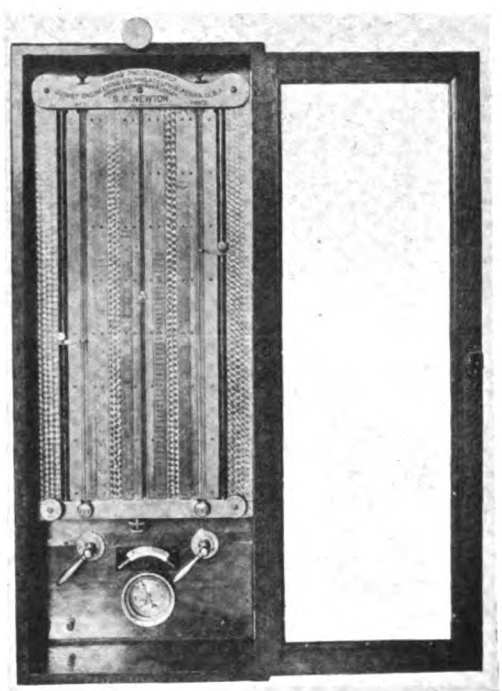

Fig. 1.—Model D-I Pneumercator

care for or repair, and the instrument itself provides means of proving absolutely the accuracy of its readings.

For centuries the draft of ships has been recorded in the same manner—viz., by the crude method of reading markings on the outside of the hull at the bow and stern of the vessel. These readings are then added together and the total is divided by 2. This figure, supposed to be the mean draft, is then applied to a scale furnished by the builder to ascertain the tons displaced. It will readily be seen that the determination of tons displaced in this manner can never be more than a guess. This in itself is the best proof of the need of a better method.

Every year emphasizes more and more the demand for unfailing, automatic accuracy. It was only from lack of a scientific, accurate, reliable, practical instrument that no improvement in recording the draft of ships has been made—until the advent of the Pneumercator. It is possible to tell time by the position of the sun, and, better still, by a watch. But mariners and scientists rely on chronometers. There is the same difference in accuracy between

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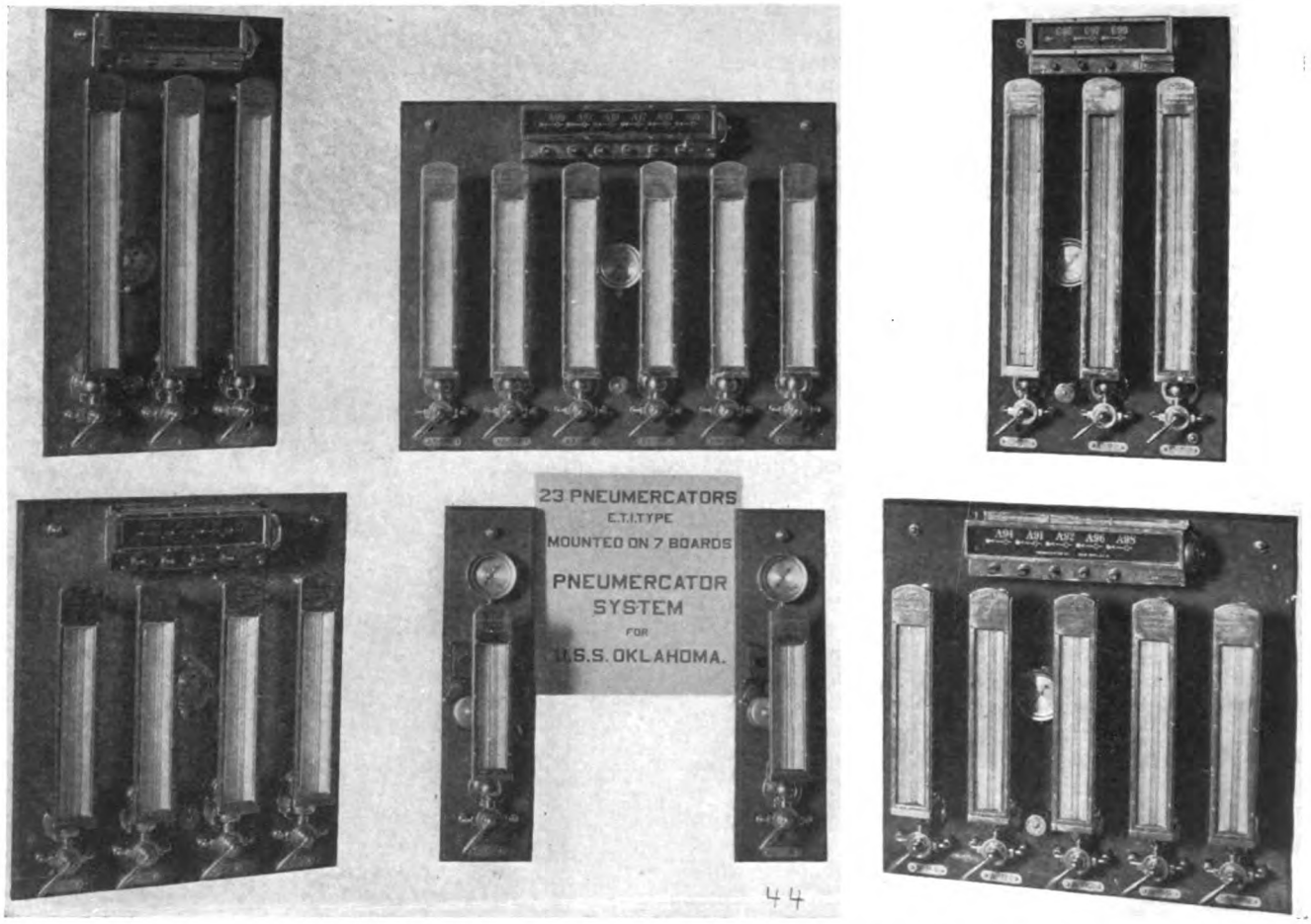

Fig. 2.—T-I and E-T-I Pneumercators Installed on United States Battleship *Oklahoma*

reading the draft of a ship by the old-fashioned gage marks and by the Pneumercator.

The Model D-I Pneumerator (Fig. 1) installed in the pilot house or chart room of a vessel is guaranteed to indicate the fore and aft drafts to within one inch and to register the mean draft and corresponding tons displaced to the same degree of accuracy. Between two successive readings of this instrument the amount of bulk cargo put in or taken out of a vessel can readily be ascertained.

In addition to being an adequate weighing device, it works equally well as a navigating instrument, as the captains knows at all times the list, trim and draft of his vessel, thus enabling him to navigate in shoal water, as well as trimming his vessel to an even keel at sea, preparatory to entering a canal.

The T-I and E-T-I Pneumercators (Fig. 2) are designed to indicate the depth and volume or weight of any liquid or semi-liquid contained in tanks either ashore or afloat, and it makes no difference whether the tank is under pressure, under vacuum or open to the atmosphere. Fig. 2 shows the instruments installed in the United States battleship *Oklahoma* to measure the fuel oil in her double-bottom tanks. These instruments furnish a perpetual inventory of the contents of the tanks—an absolute check on deliveries or withdrawals.

In an article on this very useful invention in the May issue of the *Journal of the American Society of Naval Engineers* H. B. Gregory says:

"The results obtained by the installation of the Pneumercator on the United States battleship *New York* are most gratifying. Not only has it been possible to ascertain, with accuracy at all times, the quantity of fuel in the various double-bottom tanks, but a record of the oil burned on any run has been readily obtained, and with a degree of accuracy heretofore impossible, by merely taking the difference of the gage readings at the beginning and the end of the run. Reports from the vessel on the operation of the instrument pronounce it entirely satisfactory."

Pneumercators are sold by the Pneumecator Company, Inc., New York, and many of these instruments have been, or are to be, installed on many of the vessels of the United States Navy, as well as on the vessels of numerous steamship companies.

FIRST PORTABLE DRILL AND REAMER FOR MARINE WORK.—What is believed to have been the first portable combined auger, drill and reamer ever used in marine work was built by A. Malone at Garden Island, Ontario, in 1865, and used in shipyards on the Great Lakes. The device consisted of a series of sections which could be manipulated like a folding rule with belt-driven pulleys on each joint, the auger or other tool at one end and power furnished at the other end by a donkey engine. This unique device had a working radius of about 30 feet, and would bore about twenty holes to the old hand auger's one. The application of this portable idea to the operation of drilling, reaming and grinding, of course, was rapidly extended with the introduction of small electric motors, so that to-day there are available a great variety of reliable portable electric tools which are being effectively used in shipbuilding operations. Either in shipyards or on board ship where there are holes up to 2 inches diameter to be drilled or reamed or light grinding to be done such tools are found to be indispensable.

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Development of American Oil Tankers—II

Vessels Built Since 1901—Freight Steamers Converted Into Oil Tankers—Increasing Size and Number of Oil Tankers

BY J. H. MORRISON *

The total number of oil tankers in service in 1901, exclusive of the Russian oil steamers, was about 160. Of those engaged in trade to the United States there was the Deutsch-American Petroleum Company, with sixteen steamers; the Anglo-American Oil Company, with fifteen steamers; the Shell Transport Company (British), with five steamers; the American Petroleum Company (Dutch), with nine steamers; Hunting & Sons (British), with seven steamers; Bear Creek Oil Company, with four steamers; European Petroleum Company, with four steamers; and Lane & McAndrew, with three steamers, making sixty-three steamers in all, of a gross tonnage of 225,100 tons.

Among the steamers that were early converted to oil tankers (1901 and 1902) were the *Catania,* of 2,600 tons, built in 1881 in England for the Guffey Petroleum Company; the *City of Everett,* a whaleback, of 2,600 tons, built in 1894 at Everett, Wash., altered for the Standard Oil Company; the *Paraguay,* a screw-propelled boat of 2,627 tons, built in 1900 at Lorain, Ohio, by the Sun Company; the *Florida,* a vessel of 1,600 tons, built in England in 1887 and converted by the Texas Company; and the *Louisiana,* of 2,849 tons, built at Chicago, Ill., for the same company. There were four steamers built at Chicago in 1901 for service between the Northern lakes and Europe, but the business proving unprofitable the vessels were sold to the Texas Company and converted to oil tankers for service on the Atlantic coast. They were named *Northeastern, Northwestern, Northtown* and *Northman.*

Stranding of S. S. Roma

One of the early "converted" tankers was the English steamship *Roma,* that at the time of the Galveston hurricane and flood in September, 1900, was loading grain at that port. The vessel was driven by the force of the wind through a railroad bridge and a county bridge onto a flat where there was but 6 feet of water, and as the vessel then drew nearly 17 feet of water her days of service were supposed to be ended. She remained there high and dry for several months, but later the Saginaw Steamship Company bought the vessel, brought her to Galveston through a ditch that had been dug for her transfer, and later came to New York under her own steam for alteration to an oil tanker. She is still in the same trade for the Union Steamship Company on the Pacific Ocean.

There were at this time a few steamers under the American flag that were chartered by the oil companies for a short period, but little is known of their service, excepting that some became seriously damaged by fire.

The oil-carrying companies now began to make contracts for new oil tankers. The *J. M. Guffey,* of 2,500 tons, built by the New York Shipbuilding Company for the J. M. Guffey Petroleum Company, was completed in the spring of 1902 for the transatlantic service. Some months later the Sun Company placed in service the *Toledo,* of 2,277 tons, built at Toledo, Ohio. About this time the Standard Oil Company contracted with the William Cramp & Sons Ship and Engine Building Company for an oil tanker much larger than the *J. M. Guffey,* being of 4,205 tons and named *Col. E. L. Drake.* At the same time the Standard Oil Company contracted for a similar vessel with the W. R. Trigg Company, of Richmond, Va. The latter vessel, the *Capt. A. F. Lucas,* was not completed for several months beyond the contract time on account of the financial difficulties of the contractor, but after a long delay the vessel was taken to the works of the Delaware River Iron and Shipbuilding and Engine Works (John Roach & Son), at Chester, Pa., where she was completed late in 1904. The J. M. Guffey Petroleum Company had constructed for them in 1903 by the New York Shipbuilding Company, of Camden, N. J., two more steam oil tankers, named the *Ligonier* and *Latimer,* each of 3,737 tons.

Oil Barges on the Pacific Coast

On the Pacific coast oil barges with towing steamers were first brought into service for transportation of oil, then the *George Loomis,* a small steamer of 691 tons, built in 1895, was converted to a tanker, but it was not until 1903 that the first oil tanker was built on the Pacific coast, and this was the *Whittier,* of 1,295 tons for the Union Oil Company. It was late in 1904 when the Standard Oil Company sent four or more of their large tankers to the Pacific coast for transporting oil to the East Indies. Since then the Standard Oil Company, of California, has had a large number of oil steamers in this service, among them being the *Capt. A. F. Lucas, Col. E. L. Drake, El Segundo, Maverick, Richmond* and *Asuncion.*

In 1906 the lake-built frieghters *Minnewaska* and *Minnetonka,* constructed at Cleveland, Ohio, in 1902, were cut into two parts, brought through the canal and put together again, and altered to bulk oil carriers by the Newport News Shipbuilding and Dry Dock Company for the Union Oil Company, of San Francisco. Their names were changed to *San Rita* and *San Maria.* They were each over 5,000 tons. The company sent them to the Pacific coast for service. The Associated Oil Company, of San Francisco, had constructed for them by the former builders the *W. S. Porter,* of 4,900 tons, and the vessel left for service on the Pacific coast with a cargo of oil in October, 1906.

Oil Tankers Built in 1907

The business depression of 1907 affected very largely the transportation of oil in bulk, at the same time as other freights were affected, for we find there were but two steam oil tankers built in the United States in 1907 and 1908—the *Sun,* of 4,836 tons, by the Newport News Shipbuilding and Dry Dock Company for the Sun Company, and the *Texas,* of 5,106 tons, by the Newport News Shipbuilding and Dry Dock Company for the Texas Company. During the next two years but one oil tanker was built in the country, the *J. A. Chanslor,* of 4,938 tons, by the last named builders for the Associated Oil Company, of San Francisco, Cal.

Renewed activity among the oil transport companies in increasing their fleets of bulk oil steamers soon began, however, for in 1911, 1912 and 1913 there were no less than twenty oil tankers in course of construction on the Atlantic coast and Northern lakes. It had taken ten years for fuel oil to pass through the experimental stage before

* Author of "History of American Steam Navigation."

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it began to take the place of coal as a fuel for steamers. Eight of these vessels were for the Standard Oil Company, and three were built on the Northern lakes. The next year the largest tanker thus far built was the *John D. Rockefeller,* of 8,374 tons, for the Standard Oil Company, of New Jersey, the dimensions being 458 feet 3 inches by 60 feet by 28 feet 6 inches. The *John D. Archbold,* a similar vessel in all respects, was finished a short time later for the same company. The Gulf Refining Company, successors of the J. M. Guffey Petroleum Company, had during the same year three steamers built at Camden, N. J.—the *Gulf Light, Gulf Stream* and *Gulf Coast,* each of more than 5,000 tons.

Loss of the Oklahoma

It was on January 4, 1914, that the Gulf Refining Company, of Texas, sustained the loss of their largest oil tanker, the *Oklahoma,* of 5,853 tons, built in 1908, when 57 miles south of Sandy Hook the vessel broke into two parts just aft the bridge. The vessel was on a voyage from New York to Port Arthur, Tex., and encountered a rough sea with a heavy wind blowing. Twenty-six of the crew lost their lives.

A great change in the maritime policy of our Government was effected by the act of Congress of August 18, 1914, that removed the restrictions on American registry of vessels, and its enactment no doubt was hastened by the outbreak of the European war, but a few days before. One hundred and forty-eight vessels of foreign construction obtained American registry up to June 30, 1915, and of these 37 were oil tankers. The companies having the register of their oil-carrying vessels changed were the Standard Oil Company, 25 vessels, all were formerly of the Deutsch-American Company; Gulf Refining Company, 1 vessel; Texas Company, 1 vessel; Petroleum Transport Company, of Los Angeles, Cal., 5 vessels; Mexican Company, 2 vessels; Union Steamship Company, 2 vessels; Vacuum Oil Company 1 vessel. The largest of these vessels were the *Coalinga* (formerly the *Pectan*), of 7,318 tons, British, Union Steamship Company, of California; the *Ardmore* (formerly the *Dolphin*), of 7,129 tons; the *Muskogee* (formerly the *Triton*), of 7,224 tons, and the *Standard* (formerly the *Jupiter*), of 10,073 tons.

Tank Steamers Attacked in the War Zone

Three American tank steamers have been attacked during their passage through the war zone in Europe, but fortunately none of them was sunk. The *Cushing* (formerly the *Prometheus,* of the Deutsch-American Company) was attacked by a German aeroplane on April 28, 1915, near the North Hinder Light, off Rotterdam, the Netherlands, in latitude 51 degrees 45 minutes north and longitude 2 degrees 30 minutes east, but came off without serious damage. The *Gulflight,* of the Gulf Refining Company, was torpedoed by a German submarine on May 1, 1915, off the Scilly Islands and, receiving considerable damage, was towed into Scilly. The *Petrolite* (formerly the *Excelsior,* of the Deutsch-American Company) was damaged by shell fire from an Austrian submarine on December 5, 1915, while off the coast of Tripoli, in the Mediterranean Sea, in latitude 32 degrees 23 minutes north and longitude 26 degrees 8 minutes east, but fortunately escaped being sunk.

On November 22, 1916, there were in service under American registry 73 American-built steam bulk oil carriers and 45 foreign-built steam bulk oil carriers. At this time there are under construction and contract in the United States 74 bulk oil steamers, some of them for foreign companies.

The largest bulk oil steamers placed in service since March, 1916, have been the *Charles Pratt* and the *H. H. Rogers,* of 10,900 tons each, built by the Newport News Shipbuilding and Dry Dock Company for the Standard Oil Company; while still later there have been built sixteen of the same type of steamer, the largest of them being the *Astral,* of 8,653 tons, for the Standard Transportation Company, of Delaware; the *D. G. Scofield,* of 8,651 tons, for the Standard Oil Company, of California; the *Royal Arrow,* of 7,794 tons, for the Standard Transportation Company, of Delaware; the *Sun Oil,* of 7,100 tons, for the Sun Company; the *William Rockefeller,* of 7,100 tons, for the Standard Oil Company, and the *Standard Arrow,* of 7,794 tons, for the Standard Transportation Company, of Delaware. The contracts made for new built oil steamers in the last year have been for vessels of increasing dimensions.

Improvements in Life-Saving Appliances

BY A. A. SAWMAN

Standardization of lifeboat dimensions, increased volume of internal buoyancy, heavier and non-corrosive materials, increased scantlings in keels, stems, sterns and hull plating, increased margin of safety in construction and installation of hosting devices, a continuous and efficient inspection constitute the improvements in lifeboats the last twenty years.

These improvements, of far-reaching importance, providing available and seaworthy open and collapsible lifeboats in sufficient numbers to accommodate all persons on board ocean-going vessels, have been achieved gradually. The Inspection Service from year to year has made more and more specific the rules and regulations covering the construction of life-saving appliances. In 1896 these rules covered but 5 pages, as against thirty pages in 1916, specifying the construction of lifeboats from stem to stern into the smallest details, making them uniform and practical.

Through assistant inspectors detailed to the shops of the builders a lifeboat, before it has a right to be called a lifeboat, must now be inspected, measured, gaged and examined at the yard of the builder before a name plate is allowed to go on rating the boat as a lifeboat.

Deep Sea Diving

BY M. A. LAWTON*

Since 1819, when the open diving dress was first used by Augustus Siebe in connection with a pump and helmet for supplying air under pressure to the diver, there have been, with the exception of the use of the closed dress, no very great advances made in this field until some ten years ago. From experiments made during the past ten years by the British Admiralty and the United States Navy, it has been proved beyond any doubt that to reach great depths and return successfully is quite possible.

To make such dives successfully it has been found that the shorter the time the diver takes in getting to the bottom the better, because the body absorbs less nitrogen. Also, if divers would adopt the tables prepared from experiments made in ascending and descending the danger of bends, caisson disease, etc., would be eliminated. For the diver to do effective work he must be supplied at all depths with at least one and one-half cubic feet of air per minute.

Lacing the legs of the dress not only lessens the danger of the diver's falling or being inadvertently blown to the surface, but by increasing his stability enables him to come to an erect position with ease.

* Andrew J. Moore & Son, Inc., Boston, Mass.

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Ship Classification and Registry

Origin of Classification Societies — Their Functions and Influence upon Shipbuilding — Relations with Underwriters

BY STEVENSON TAYLOR*

WHAT is the meaning of the term "ship classification" and what are the objects and purposes of a classification society?

Frequently is this query made and it is the endeavor of this article to elucidate as concisely as possible the functions of societies inspecting and classifying the common carrier of maritime commerce.

The primary object of classification societies was the maintenance of a register in which was recorded the principal particulars of each vessel's hull, machinery and equipment, giving the date and place of build, builder, owner and material built of and the assignment of a class designated by a symbol indicative of the strength and general seaworthiness of the vessel for insurance purposes.

Classification Rules

In the course of time it became necessary for classification societies to promulgate rules relating to the structural requirements which if observed in the construction of a vessel would entitle her to be assigned the highest classification. Modern classification rules not only deal with the vessel's hull, machinery and equipment but dictate the strength and quality of the material entering into the construction of the hull, machinery and equipment of the vessel. Classification societies, therefore, are technical bureaus of the highest value to the whole shipping community. Their rules comprise the ideas and knowledge of the foremost men in the professions of naval architecture and marine engineering and their methods encourage developments in structural design.

To obtain a faithful and accurate classification of mercantile shipping it is incumbent upon all registers to employ a large corps of naval architects, marine engineers, inspectors and surveyors, located in all the principal ports of the maritime countries of the world. The office of surveyors is referred to in a register book as early as 1781, but as early as 1768 repairs were superintended by the officers of a classification society. In 1824 appeared the first "Instructions to Surveyors," relating to carrying out rules for classification.

Leading Classification Societies

The important classification societies of the present day are the Lloyds Register of British and Foreign Shipping (commonly called British Lloyds), Bureau Veritas, American Bureau of Shipping, Det Norske Veritas, British Corporation for the Survey and Registry of Shipping, Registro Nazionale Italiano and Germanischer Lloyds.

Lloyds Register of British and Foreign Shipping, being the oldest, is generally considered to be the premier of classification societies. The Lloyds comes from Lloyd's Coffee House, where merchants met daily at luncheon and discussed questions relating to shipping. The earliest printed Register known is dated 1764.

British Lloyds Register as now organized was instituted in 1834. Financial support was given to it by Lloyds and other insurance underwriters, a great amount was subscribed and there was issued the first volume of Lloyds Register of British and Foreign Shipping. There was also issued at this time precise regulations regarding the survey of vessels.

Bureau Veritas was founded in Antwerp in 1828 to acquaint the underwriters with the qualities and defects of the vessels trading to Dutch and Belgian ports. The headquarters of this society were moved to Paris in 1832.

American Bureau of Shipping

The American Bureau of Shipping was established in 1862 under the name of the American Shipmasters' Association, and in 1867 its first publication, known as the Record of American and Foreign Shipping, was issued. The name American Shipmasters' Association was changed in 1898 to the American Bureau of Shipping.

The British Corporation for the Survey and Registry of Shipping was established in 1890. The society was formed as the result of fears lest the granting to British Lloyds Register of the power to fix load lines might operate against the interests of shipbuilders and shipowners. As a result of its influence an addition was made to the Load Line Bill granting the British Corporation the right to establish loads lines the same as given to the British Lloyds Register. From an organization formed for this limited object, the British Corporation developed into a classification society. This corporation has undoubtedly had a very great effect on shipping developments, notably in structural methods and in types of ships.

Influence of British Corporation

The advent of the new corporation gave a great impetus to noteworthy developments in the art of ship designing and construction. The British Corporation thus founded has been remarkably successful and undoubtedly has had its effect in rendering shipbuilding methods more elastic and progressive. At first the naturally conservative instincts of shipowners rendered the progress of the new registry slow, but each year the tonnage built under the new rules has steadily increased.

Registro Nazionale Italiano was formed in 1910 to take over and rejuvenate the Registro Italiano formed in 1861.

Det Norske Veritas of Norway was established in 1864 by the various marine insurance clubs as an economic measure. Prior to this date each club or company had its own staff of surveyors.

Germanischer Lloyds of Germany was organized in 1867 and reorganized in 1889.

From the earliest period of insurance underwriters recognized the important factors of the strength, age and upkeep of vessels in their estimate of maritime risks on hulls and cargoes.

Interests Served by Classification

It will be noted in the brief reference to the classification societies mentioned above that each register had its inception among insurance companies and underwriters. But here it is well to digress for a moment to correct any misapprehension that a classification society serves and conserves only the interests of the underwriter. This is

* President American Bureau of Shipping and president Society of Naval Architects and Marine Engineers.

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not so, because it also conserves the interests of the shipbuilder and the owner as well as the shipper.

The shipowner is under no obligation to comply with the requirements of a classification society, but it is much better that he should, because the testimony of a classification society as to the construction and equipment of a ship is a certificate of character favorably considered by underwriters. Lacking such certificate the underwriters are warranted in asking higher rates of premium than when the ship is so provided.

Another important and controlling factor is the competition as freight carriers. Shippers insuring their cargoes naturally seek the vessel which will permit their obtaining insurance at the lowest premium, all other factors being equal.

Classification Symbols

Each society or register has its individual symbol indicating the classification of the ship. For instance, Bureau Veritas has the numerals 3/3—1.1 for the highest classification. The record of American and Foreign Shipping, published by the American Bureau of Shipping, assigns ❖ A—1. British Lloyds class is indicated by the following: ❖ 100 A 1, and The British Corporation for the Survey and Registry of Shipping is represented by B. S. ❖.

It is well to point out here that there is a general misunderstanding of British Lloyds classification. The 100 A 1 of British Lloyds does not, of course, mean one hundred years A 1, but is indicative of the highest classification, and is the symbol which superseded their original A 1. In other words, 100 simply means par.

British Lloyds Register as it exists to-day is a good illustration of the advantages of co-operative effort. It is of interest to practically every class of the shipping community to be able to ascertain the character of a given vessel. This is equally true of all classification registers. For the information of those not fully informed on this subject it might be well to state that there are two great institutions connected with shipping; each working independently of the other, both, however, using the name "Lloyds." One is the great marine insurance combination of individuals known as Lloyds of London; the other is the classification society, British Lloyds Register.

For a number of years British Lloyds Register had practically a monopoly of the classification of vessels upon which insurance would be written at favorable rates. This was true until a short period ago—to be specific, the outbreak of hostilities in Europe, since which time the amount of insurance carried by insurance companies in this country has increased to such an extent that it is no longer necessary to look to London for the acceptance of the risk. This is due to the increase in the number of American insurance companies now taking marine risks and the increase in the lines taken of the older companies.

Increasing Business for American Insurance Companies

A representative of one of the large shipbuilding companies states that out of a total of $6,000,000 (£1,230,000) of builders' risk insurance placed since December, 1915, over 63 percent was placed with American companies and very little of which, if any, was reinsured in foreign companies. This representative expresses the opinion that shortly all American builders and owners will be able to place their entire insurance in this country.

Likewise, classification of a vessel by the British Lloyds Register is no longer a necessary adjunct to obtain favorable rates of insurance. At a recent discussion by marine underwriters on the topic of writing marine insurance in America one underwriter stated that he placed $1,000,000 (£205,000) insurance on each of two vessels in one yard and that it had all been placed in the United States, though a portion of it was reinsured abroad. Another says: "Insurance can now be placed to any amount on the classification of the American Society, the American Bureau of Shipping." A third, a member of one of the largest establishments in the United States for placing insurance abroad, says positively: "A dual survey (that is, for instance, British Lloyds Register in addition to that of the American Bureau) is unnecessary, as an American Bureau Record survey is completely satisfactory for all insurance purposes." A fourth underwriter says: "Not only is insurance on American vessels being taken almost entirely in the United States, but that his firm is now placing here insurance on foreign ships for foreign owners."

To conclude, classification is for the use of all classes of business interested in shipping. Owners can demand that vessels contracted for shall be built according to the rules of the society. Builders, when making a contract to build according to these rules, know just what they have to furnish on all important matters connected with the construction and outfit of the ship. In all countries having classification societies and such organizations of their own, the rating given by these institutions forms the basis of marine insurance of both hulls and cargoes. The record, or register book, of these societies is constantly consulted by marine underwriters the world over for particulars regarding the construction, condition and seaworthiness of the vessels classed. Shippers learn whether or not they may intrust cargoes in certain vessels, and purchasers, by the same record, determine whether to buy or not.

In brief, there is no interest in shipping that cannot be benefited by the classification issued by a recognized classification society, and at this particular period of rapid growth in an American merchant marine there is every reason to believe that the American Bureau will do its part in a thorough and efficient manner excelled by none.

Improvements in Small Tools

In the last twenty years there has been no other product of commercial manufacture that has been improved as much as that known to the trades as small tools, such as twist drills, reamers, taps, cutters, counterbores, etc.

An immense amount of testing and experimenting, at a large cost to the manufacturer, with steels, to obtain the best; with forms of teeth of cutters; the flutes of reamers; the pitch of the twist of drills; the points and webs, as well as the clearance; the clearance, grooves and squares of taps; and the testing of tempers, to obtain the very best results in order to satisfy the new demands, would, if fully detailed, fill volumes, with numerous drawings and much data to illustrate the ideas and forms.

Some of these changes were radical and other changes simply ordinary, but all of great efficiency, as any fair-minded consumer will testify when he knows the greater productive power of his own plant.

The advent of high-speed steel caused a revolution not only in the manufacture of small tools, but in the design and building of machinery to use them. Thus the experiments were necessary to determine the best steels, the best heat treatment, the best forms of tools, and bring about the most efficient results. The result is that the demands put upon the manufacturers of small tools, either carbon or high speed, are so much greater than years ago that the business is almost entirely new. The manufacturer who could not have met or handled the conditions would have been but a memory to-day.

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The Part Played by Rivets in Shipbuilding

Materials Specified by American Steel Manufacturers — Shearing Strength of Rivets—Design of Rivet Heads

BY DAVID J. CHAMPION*

ANYONE who has given the subject even casual thought must realize what an important part rivets take in the construction of modern vessels. In the early days ship carpentery was considered one of the desirable trades, and men schooled in it were in great demand. In fastening ship timbers together trunnels, or tree-nails made of green heart or ironwood, were used extensively, so were dowels and copper bolts. Later on wrought iron spikes were used for the same purpose.

Ever since the days of the inception of metal shipbuilding, rivets have played an important part in their construction. First, iron rivets were used, as in those days steel rivets were unknown. Later on, however, steel rivets were substituted very successfully.

In the early days steel plates also were not considered trustworthy for shipbuilding purposes, as in those days it was difficult to procure good open-hearth steel, and the Bessemer was often substituted, but always at a great risk of life and property. On the Great Lakes the older ones among us will remember the sad accidents which befell the steamers *Peter Minch* and the *Western Reserve,* in the fall of 1887, both vessels being lost through the shearing of the rivets or the fracture of the plates used in their construction.

With the progress of time great improvements were made in steel suitable for shipbuilding purposes, and to-day open-hearth steel is considered the acme of perfection. Experience has taught us that the best basic open-hearth steel, or acid open-hearth steel, is what should be used for rivets.

The American Society for Testing Materials, which is an offshoot of the American Society of Mechanical Engineers, has given this subject a great deal of thought and consideration. This society, in conjunction with the American Steel Manufacturers, has placed before the world invaluable data governing the manufacture of steel for shipbuilding purposes. These data are compresenhive and are published with such lavish explicitness that it is hardly necessary to detail the information in this article, but the reader is respectfully referred to the specifications issued by the Association of American Steel Manufacturers, dated April, 1914, and also the specifications published by The Carnegie Steel Company, and other large steel manufacturers, dated January, 1914, all of which are worthy of study by those interested in this direction.

Steel to-day in the shape of boiler plate, bars, shapes or rivets is ideal compared with the product put before the public a quarter of a century ago. Failures in the use of it are now very rare. The steel maker knows how to make it, the workman understands better how to handle it, and there is no question but that their work will come up on final test to their highest expectations. In line with the progress of the age in which we live, more and more is expected of every piece of machinery manufactured, and if it were not for the improvements made in the manufacture of steel it would be a physical impossibility to accomplish what we are achieving to-day.

Perhaps the most important point in connection with ship rivets is the shearing strength. This, in connection with the design of the rivet head, which should fill the hole properly, is of paramount importance to the shipbuilder. The greatest success has been attained with the use of what is known as the pan-head, swell-neck rivet. The great advantage of using this style head for marine purposes is freely acknowledged by all the leading shipbuilders and endorsed by them in their regular practice. These rivets are made to fill holes in *punched plates.* The diameter of the punched hole on the die side is always slightly larger than the hole on the *punched side.* In other words, the *punched hole* is of *conical* shape.

In assembling, the plates are *reversed,* and by the use of swell-neck rivets the holes are completely filled and the production is increased to a maximum, while the loss occasioned by loose rivets is reduced to a minimum.

The strength of the joint is further increased by the use of steel made according to Lloyds, or United States Navy specifications for similar quality of steel, which adds at least 5,000 pounds to the shearing strength and 10,000 pounds to the tensile strength.

* President Champion Rivet Company, Cleveland, Ohio.

Heating of Rivets by Gas and Oil Compared

A test recently made by the Newport News Shipbuilding & Dry Dock Company to check the cost of operating a rivet-heating furnace by gas as against the oil furnace formerly employed showed that more time was required by the gas furnace and the fuel cost was also increased. The results, it is understood, showed that 400 pounds of rivets were heated in the oil furnace in 44 minutes at a cost of 52.5 cents, assuming that oil cost 6 cents per gallon, while the cost of heating a similar quantity of rivets in a gas furnace with gas at 55 cents was 53.6 cents and the time required was 57 minutes. It is stated, however, that the rivets heated in the gas furnace were better than those heated in the oil furnace, as there was practically no scale upon them, while those heated by oil were badly scaled in a number of cases. The gas-heated rivets are said to stay hot enough to drive longer than those heated in an oil-fired furnace, because the former are thought to be heated evenly all the way through, while the oil-heated rivets are extremely hot on the outside but are not hot in the center and thus cool more quickly.—*Iron Age.*

Greasing the Ways for a Launching

Twenty years ago when a ship was launched it was the custom to use plain tallow, put on the ways with a mop and smeared over with soft soap. In cold weather train oil was frequently used, mixed in with the tallow.

The present-day method is to use stearine, which is best heated and applied to the ways, then tallow and launching grease and sometimes lard oil is spread over this mixture. In the earlier period mentioned these refinements were not known, but on account of the large tonnage of the vessels being launched the latter method is safer.

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Present Steamship Lighting Compared with That of Twenty Years Ago

First Vessels Lighted with Electricity—Advent of the Tungsten Lamp—Lighting of the Steamship Imperator

BY G. L. SEALEY*

ELECTRIC lighting on steamships has not kept pace with the development of electric illumination in other fields. This may be due to the natural backwardness of the seaman to adopt anything new, or it may be attributed to his desire to retain the old and tried methods of lighting vessels that have been used for long years back. The more progressive companies have tried to keep up with the advances, and, as a result, we find many widely different types of illumination on ships operated from the same ports.

Comparatively modern vessels have been lighted by candles, candle-lanterns, and oil lamps. Many of these systems have been superseded by gas lamps, operated from tanks of compressed gas located on the decks. The advent of incandescent lamps has antiquated gas lighting systems and the latest steamships are equipped with lighting systems comparable with those found in our modern hotels.

Probably the first record of the use of electricity as a means of lighting large ocean-going steamships, is that of the installation on the *City of Bristol,* in November, 1879. About the same time—1881—incandescent lamps were first used on the Cunard steamship *Servia.* These are the earliest reliable records of instances of electric lighting on steamships, although it is very probable that incandescent lamps were used on private yachts some time previous to this date.

For the next few years after the installation of the first lighting system on board ocean-going vessels the progress in this line was rather slow. Typical installations of twenty years ago did not take advantage of reflectors. The old-style carbon filament lamps of about 16-candlepower were used to a great extent. Single units of higher candlepower were not in every-day use at that time and clusters of smaller lamps were used to produce the effect of a large concentrated source. These clusters were generally enclosed in some sort of dome and were supplemented by wall lamps and hanging lanterns. The earlier lamps were all mounted bare, then frosted lamps were used, and later shades were introduced. A large proportion of the bulbs used were round in shape, somewhat similar to the lamps used for automobile service, although larger in diameter. Lighting was done more for business purposes than for the comfort of passengers, and none of the lighting systems was at all elaborate. A large number of small units of low candlepower were distributed throughout the area to be illuminated and the resultant light distribution was neither high in intensity nor entirely satisfactory.

Considerable progress has been made in many respects in the lighting of steam vessels in the last twenty years, but there are still very many examples of rather poor illumination. The unshielded incandescent lamp is still used to quite a large extent, probably because of its ease of replacement and convenience of distribution. However, many shipowners have realized the inefficiency of the older methods of installation and the present-day tendency seems to be towards the adoption of more modern and consequently more efficient units.

The standard 110-volt lamp of either carbon or tungsten filament is used almost exclusively. The tungsten filament construction is a modern innovation, as the first tungsten lamp was manufactured only a few years ago. Higher-wattage lamps with tungsten filaments are now being used and lamps of 250 watts or 500 watts have taken the place formerly held by mercury arc and carbon lamps in lighting large spaces on all types of vessels. Twenty-five and 40-watt tungsten lamps are widely used for the illumination of staterooms, passageways, and other places where a high illumination is not necessary. The lighting systems have undergone a great deal of improvement, and on large passenger steamers we find concealed lighting, indirect cove lighting, semi-indirect, direct and decorative lighting. Swinging fixtures cannot very well be employed because of the motion of the ship, but similar stationary arrangements give very satisfactory results. Government vessels and battleships are equipped with the most modern installations. Here the engineers have gotten away from the idea that since electricity must be produced for various uses on the ship other than for lighting, the cost for lighting need not be considered. The ruggedness of tungsten lamps as constructed at present has advanced the adoption of this type of lighting. Mazda lamps are used on battleships, where they have been forced to undergo heavy vibration, due to to the firing of broadsides and have been found intact after such severe usage.

A brief description of the lighting of the steamship *Imperator* will serve to give an idea of the lighting of a typical modern vessel. Here an ingenious adaptation of "sky-light" lighting gives one of the rooms actually deep in the bowels of the ship the appearance of an open-deck compartment. The ceiling is divided into 75 panels of diffusing glass, behind which there is mounted a ring-conduit fixture supporting four 40-watt tungsten lamps. These units project a uniform diffused illumination upon the space below, filling the entire apartment with an unusually agreeable quality of light.

At the level of the intermediate deck a visitors' gallery encircles the room behind pillars. Passageways beneath the gallery are lighted by indirect domes set into the low ceiling. For the visitors' balcony, wall bracket fixtures equipped with electric candle-lamps afford sufficient illumination.

Nearly 10,000 incandescent lamps are used for lighting the decks and cabins of the *Imperator.* The turbine-driven generating equipment aggregates 200 kilowatts, in addition to which there is an emergency set driven by an internal-combustion engine, located on the upper deck, which is held in reserve to furnish energy for corridor lighting and wireless signaling in case the main engine-room should be flooded.

The improvement in steamship lighting in the last twenty years has been very great, but there is still a chance for further development, and future lighting should show an advancement comparable with the great strides the electrical industry is taking at the present time.

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Two Decades of Lighting for Ships and Shipyards

Adequate Illumination of Shipyards Unknown Twenty Years Ago—Improved Lights and Lighting Systems

BY A. R. DENNINGTON*

TWENTY years ago the use of artificial lighting was limited by the lighting units available, so that a condition approaching adequate illumination for industrial establishments was unknown. Shipyards, foundries and similar plants of large area were lighted by arc lamps or by open-flame gas lamps. Local lighting for the individual workman was provided by a bare carbon lamp or by a smoky torch. Very little attempt was made to use shades on incandescent lamps in industrial plants, and in general the intensity of lighting was much less than that which is now considered a usable minimum.

The conditions outlined may be contrasted with those existing to-day. The variety and sizes of lighting units are almost unlimited. The old open-arc lamp has almost disappeared, as it has been displaced by more powerful and more efficient units. To-day the shipyard may be lighted so effectively that work can be carried on at night with as great efficiency as during daylight. The light sources available are flaming arc lamps, Cooper-Hewitt mercury vapor lamps and Mazda lamps. The latter are made in all sizes to meet the requirements imposed by small or large spaces.

In ship lighting the development during the past two decades has been in the gradual change from carbon to Mazda lamps and the increasing use of semi-direct and indirect lighting on passenger steamers. The older method of ship lighting was to stud the ceiling with bare or frosted lamps, and as the ceilings were low the effect was rather glaring. With the use of lamps much brighter than the old carbon came the necessity for the use of diffusing glassware and reflectors to direct the light where it is needed.

Searchlights have been greatly improved and have become much more powerful during recent years and are now an essential part of the equipment of every ship.

The modern ship is hardly complete without a few miniature lamps, which are used as binnacle lights and chart lights and in some cases for producing the low illumination required in the pilot house.

* Westinghouse Lamp Company, New York.

Control of Fire in Marine Properties

Automatic Water Sprinklers Installed for Protection of Marine Properties Afloat and Ashore

BY IRA G. HOAGLAND*

PROGRESS in applying automatic water sprinklers to marine properties afloat and ashore for protection from fires has been made only during the past decade, while in connection with land properties it began thirty-five years ago. Marine properties most extensively protected by sprinklers are wharf sheds and dock storehouses. Quite a few shipyard buildings, mainly woodworking shops, are also thus protected. But as yet only a few vessels—most of them fresh-water passenger craft, particularly Long Island Sound steamers—are fitted with sprinklers. The most extensive sprinkler installations in vessels are in the *Imperator* and *Vaterland* of the Hamburg-American Line.

Fully seventy individual wharf properties in the United States are sprinklered, and many more dock storehouses —there are 110 in the Bush Terminal—in the port of New York. About two-thirds of these wharves are on the Atlantic Coast and the remainder, with the exception of a few in the interior, are on the Pacific Coast. Nearly 60 percent of the number on the Atlantic Coast are in the port of New York. Ports having two or more sprinklered wharves are as follows: New York, 26; Seattle, 8; Boston, 6; Los Angeles, 5; Philadelphia, 3; Norfolk, 2; San Francisco, Cal., 2; Portland, Ore., 2; Tacoma, Wash, 2.

The greatest number of sprinklered wharves in one group are the seven at the Bush Terminal. Since sprinklers were installed, there have been ten fires in these wharves, all successfully controlled by sprinklers, and most of them were nasty blazes in cotton and jute, pregnant with possibilities of disaster like the fire which burned Pier No. 7 in 1904. In 1899 firemen fought a cotton fire in the Bush stores for 38 days. On June 13, 1915, 119 sprinkler heads opened and controlled a fire in 5,280 bales of cotton on Pier No. 1 in ten minutes! Besides the wharf sheds and storehouses there are sprinklered loft factories at the Bush Terminal, and, in all kinds of buildings, there have been 100 fires controlled by sprinklers, and so successfully that $300 (£62) would cover the total property loss.

Nearly 50,000 shore properties are sprinklered. This has effected an economic conservation in life, property and business saved from fire, and in reduction of insurance cost, which, measured by money, amounts to more than $3,000,000,000 (£615,000,000). Of 20,000 fires, 96.4 percent were successfully controlled by sprinklers. In sprinklered properties, fire losses average $250 (£51), and in those that are not, the average is $25,000 (£5,125)!

* Fire Prevention Engineer, New York

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An insurance company which underwrites only on sprinklered properties, while increasing its business 7,000 percent, reduced its loss ratio 84 percent! The record of sprinklers ashore speaks for itself, and what has been done ashore can be done at sea when marine engineers realize that it is much more effective to spray water over a fire than to reach it from below by partially sinking a ship. Interest in protecting ships against fire has been stimulated by conferences held in Washington in 1916, under the direction of Secretary of Commerce Redfield, which may have the effect of accelerating progress in using automatic water sprinklers for this purpose.

Progress of Refrigeration in the Marine Field

Rapidly Increasing Use of Refrigeration for Ship's Cargoes and Stores—The Principal Refrigerants and Methods of Insulation

BY H. HARRISON

MECHANICAL refrigeration for marine service owes its start to a need for adequate transportation facilities for meat from countries where the supply very much exceeded the demand to countries where the reverse was true. It owes its growth to the ever-increasing necessity for perishable commodity equilibrium between the several countries; to the universal movement for comfort, sanitation and economy, and to the hearty and able cooperation received from marine engineering in adapting this class of apparatus to the special requirements and conditions obtaining on board ship.

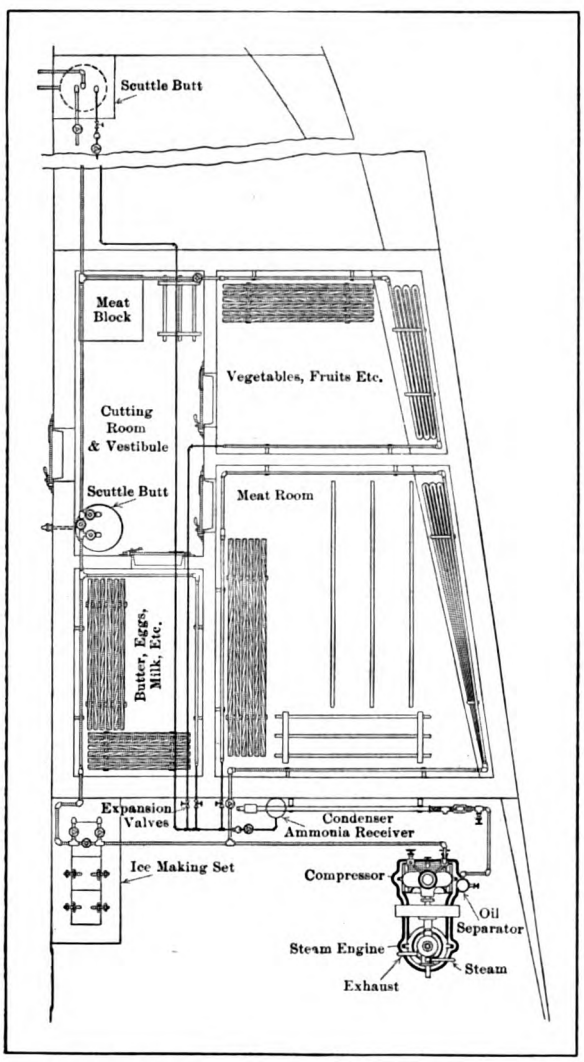

Fig. 1.—Typical Layout of Refrigerating Plant on Board Ship

The progress in the last twenty years is evidenced by the increased number of installations (see Fig. 3), by the increased field of application, by the better appreciation of the investment value of good insulation, by the better understanding (so necessary for a choice) of the chemical and physical properties of the several refrigerants and by the certainty with which the performance of apparatus can now be guaranteed.

Beginning with installations devoted exclusively to cargo storage of meat, we now have marine engineers applying refrigeration to the following:

A. Cargo Storage—
   a. Meats: Chilled (34-38 degrees F.); frozen (12-18 degrees F.).
   b. Fruits (40-45 degrees F.).
   c. General Perishables: Dairy products, eggs, fish.

B. Ship's Service—
   a. Stores: Crew, passenger.
   b. Drinking water cooling.
   c. Ice making.
   d. Air conditioning for staterooms, dining saloons, etc. Temperature about 10 to 15 degrees F. lower than outside, provided outside temperature is over 80 degrees F. Relative humidity about 60 percent.

C. Ammunition magazines on naval vessels (60-70 degrees F.).

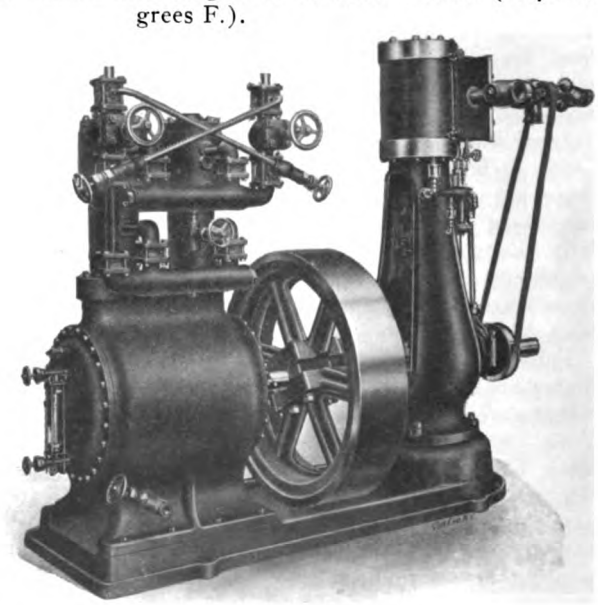

Fig. 2.—Refrigerating Machine, Manufactured by the Brunswick Refrigerating Company

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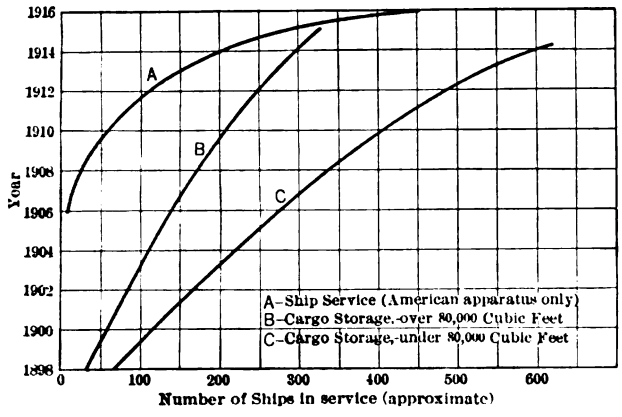

Fig. 3

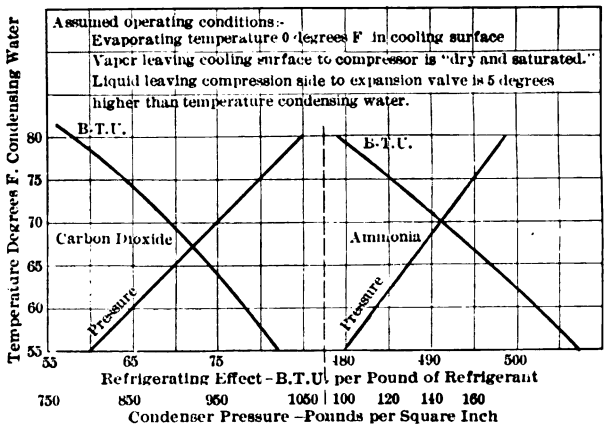

Fig. 4

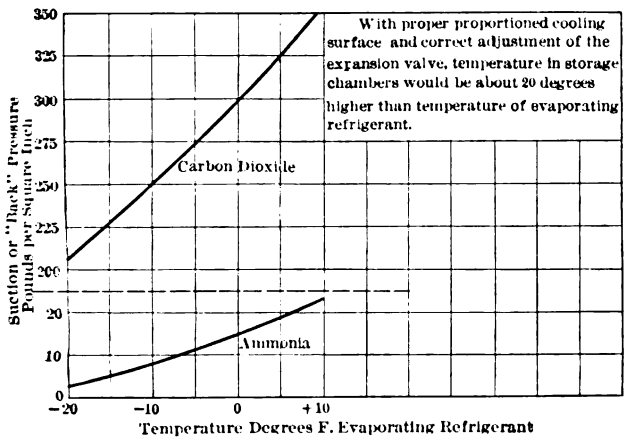

Fig. 5

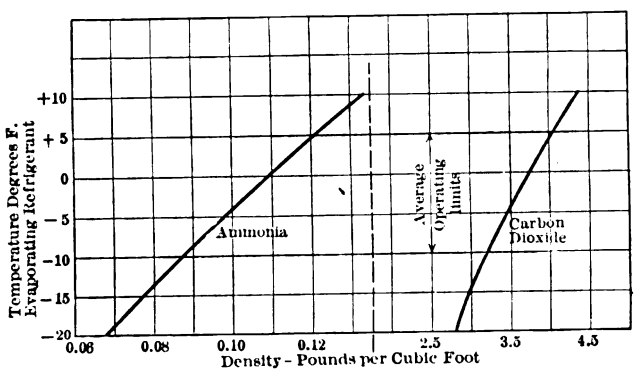

Fig. 6

Refrigeration for ship service has made the greatest progress, both in the matter of number of installations and variety of applications, the development being distinctly American, because the small machines usually required for this service have here received their greatest perfection in reliability, simplicity, economy and comparative low first cost. Fig. 1 shows a typical layout; note the compactness. Fig. 2 shows an American machine; note the evident simplicity.

There are three methods now in use for delivering the cooling effect of the refrigerant—namely, direct expansion, brine circulation and forced air circulation. Marine engineers now realize that no one method can be said to typify best practice; that layout, temperatures required, kind of goods to be stored, and also first cost are the determining factors in the choice. In general, however, direct expansion is the choice for compact layouts in ship service and the smaller cargo storage installations; brine circulation for the larger cargo storage installations and for ship service having scattered layouts; and forced air circulation for cargo storage of fruits and conditioning of air.

Until rather recently powdered charcoal, sawdust, silicate cotton and air spaces, all with board and paper reinforcement, were generally used for the insulation of cold storage chamber walls, ceilings and floors. This class of insulation is being rapidly superseded by pure sheet cork. Pure sheet cork offers per inch thickness maximum resistance to heat flow, and as it is at the same time structurally strong and neither packs nor absorbs moisture, it is an ideal and permanent insulator.

In the past twenty years some half dozen refrigerants have contributed with more or less effectiveness to the progress of marine refrigeration. Of these we still have sulphur dioxide, ethyl-chloride, dense air, carbon dioxide and ammonia. With chemical and physical data now available the selection of the more desirable refrigerants is chiefly based on individual and collective analysis of the following, and since carbon dioxide and ammonia are the leading refrigerants Figs. 3 to 6 are included for ready comparison of their physical properties within average operating limits:

(1) Suction pressure corresponding to an evaporating temperature about 20 degrees lower than temperature desired in storage chambers. If pressure is below atmosphere, special but more or less unsatisfactory construction is necessary to prevent entrance into the system of air and other foreign gases. If pressure is much above atmosphere, special but more or less unsatisfactory construction is necessary to prevent leakage of refrigerant (Fig. 4).

(2) Condenser pressure corresponding to available condensing water temperature. If pressure is too high, expensive construction is required, and even with such leakage of refrigerant is not preventable (Fig. 5).

(3) Latent heat of evaporation at suction pressure. If too small, requires the circulation of excessive weight of refrigerant and, further, with high temperature condensing water the loss in refrigerating effect per pound is very high in proportion to the total heat available, and therefore requiring still further increase in weight of circulating refrigerant (Fig. 5).

(4) Density or weight per cubic foot at suction pres-

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sure. If low, requires larger compressor displacement, but in this connection item 3 must be taken into consideration, as this may offset, in greater part at least, any advantage due to density.

(5) Chemical action of refrigerant on such metals as are reasonably available for the construction of the apratus and chemical disintegration of the refrigerant due to continued re-circulation.

Refrigeration is now a highly specialized engineering profession and is becoming more so every year owing to the activities of the American Society of Refrigerating Engineers, the progressiveness of the leading manufacturers of refrigerating machinery and the interest displayed by, and scientific tests performed by, the United States Bureau of Standards. As a result of the foregoing, and what probably indicates more than anything else the remarkable progress in this industry during the last twenty years, is the disappearance of uncertainty and doubt as to the performance of apparatus, positive guarantees now being given as to expected results.

Development of Deck Auxiliaries

Factors Influencing Changes in Design of Ship's Winches, Windlasses and Steering Gear

BY G. E. SMITH *

THE changes in type and design of deck auxiliaries during the past twenty years have been principally along three lines: (1) Greater speed in ship and less lost time in terminals; (2) increased size of vessels; (3) application of electricity.

1. The inclination to increase speed has caused the development of larger and more powerful steering gears for the same size vessels, as well as the design of larger cargo units to handle increased tonnage of the modern steel vessel equipment of to-day.

The desire to reduce terminal delays has fostered the development of special cargo-handling winches and the use of multiple winches at each hatch, in order to handle the cargo in the least possible time. This has resulted in a gradual decrease in the use of the more common double drum winches and the substitution of single drum winches, highly standardized and constructed for rapid and continuous service.

This era of speed has also been felt in windlass requirements for anchor handling. Previous chain speeds, with the older worm-geared windlasses, of approximately three fathoms per minute, have given place, with the more efficient and higher powered spur-geared windlasses (which are to a large extent the recognized standard of the day), to six fathoms per minute.

2. The increased size of vessels has brought about radical changes in point of design, especially of windlasses and steering engines, due to the inability of the owners and builders to concede a proportionate increase in space for the auxiliaries on these larger vessels. This has resulted in the more common use of steel in place of cast iron and the introduction of different types of machines for the same duty, in order to procure units of greater power in equal or less space. This increasing size in the vessels, with its consequent heightened investment, has made materially more important the question of delays, and this in turn has magnified the importance of standardizing parts and machines for interchangeability and quick repairs.

3. The development of the electric machine as exemplified in deck auxiliaries has been somewhat slower than the application of electricity in other fields, both on account of the prevalent use of steam aboard ship and the fact that while deck auxiliaries are usually used for short periods of time only, the maximum load requirement is greater than the normal generator output of the vessel.

The electric winch for cargo handling is comparatively little used. The electric windlass for pleasure boats is in quite extensive use. It is not often employed for commercial vessels, except on fuel oil ships, but in the navy it has practically superseded all other sources of power. Steering engines remain practically all steam-driven, except for naval work, where electricity is now uniformly used.

In addition to the above, occasional applications of the gasoline (petrol) engine have been made, but these have been too infrequent, as yet, to be considered in the nature of a standard development.

At the present time, electro-hydraulic steering gears are being adopted by the United States Navy, and to a limited extent for commercial use, and while the outlook in this direction is encouraging it is too early to prophesy to just what extent this type of gear will be adopted.

Ships' Windlasses

The following is a description of the later types of windlasses now furnished for both merchant and naval vessels by the Hyde Windlass Company, Bath, Me.

The steam windlass illustrated in Fig. 2 is fitted with an auxiliary shaft on which are carried warping heads for quick handling of line. The speed for taking in lines on the auxiliary warping heads is five times as fast as with the warping heads on the ends of the windlass shaft.

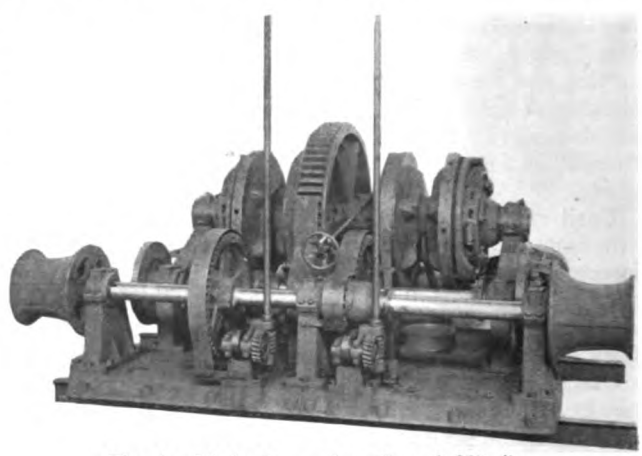

Fig. 1.—Hyde Steam Spur-Geared Windlass

* Chief engineer, American Engineering Company, Philadelphia, Pa.

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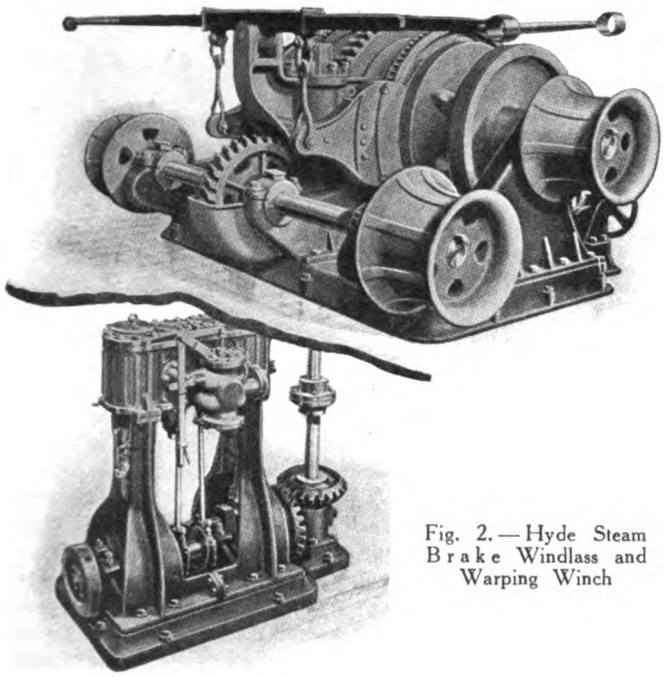

Fig. 2.—Hyde Steam Brake Windlass and Warping Winch

This combination makes a very powerful warping attachment and takes the place of the independent steam capstans usually furnished and located forward on steamships for this purpose.

The steam spur-geared windlass illustrated in Fig. 1 is a type much used. The engine is self-contained on the same bedplate with the windlass. Warping heads are arranged on an intermediate shaft as shown and are used for warping the ship in the same manner as in the worm-geared windlass above described.

The steam vertical windlass illustrated in Fig. 3 is a type of windlass much used on large merchant vessels and also adopted by the United States Navy Department as a standard for all naval vessels. This type makes a very neat and compact arrangement above deck, and the chains have a much more secure hold on the wildcats, where they warp around the wildcats a distance of 180 degrees.

Fig. 3.—Hyde Steam Vertical Windlass

Ships' Winches

While little or no change has been made in the general design of ships' winches during the past twenty years, mechanical changes and improvements, however, have been made. There is to-day a tendency toward using more wire rope than Manila rope in connection with winches. This is because of two reasons, first, the excessive cost of Manila and, second, the speed in handling Manila is dependent upon a man's ability to take it off a

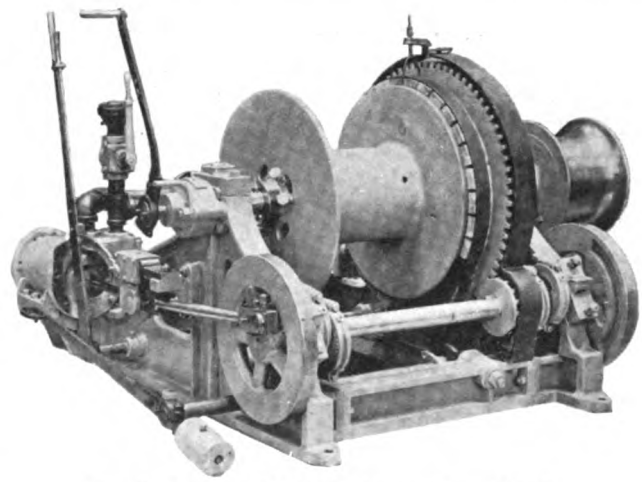

Fig. 1.—Lidgerwood Single-Friction Drum Winch

winch head. With the wearing qualities of wire rope greater and higher speed obtainable by winding it on a drum, this change has caused differences in the deck arrangement of winches, permitting more winches to be used to a hatch.

An excellent example in modern arrangement and type of winches is found on all the new large freighters of A. H. Bull & Company, New York.

These are single-friction drum winches (Fig. 1), manufactured by the Lidgerwood Manufacturing Company, New York. All but two winches on each ship have 8¼ by 10-inch cylinders. Each hatch has two winches. At hatch No. 2 the winches have 9 by 10-inch cylinders and are fitted with reverse link motion. The drums are so arranged that they can be bolted to the gear. This fea-

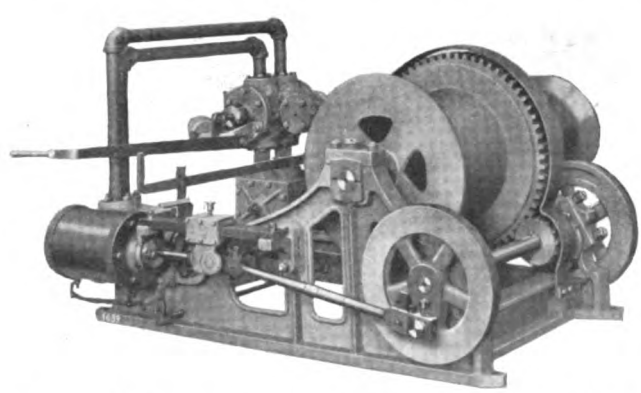

Fig. 2.—Lidgerwood Single-Keyed Drum Steam Reserve-Valve Winch

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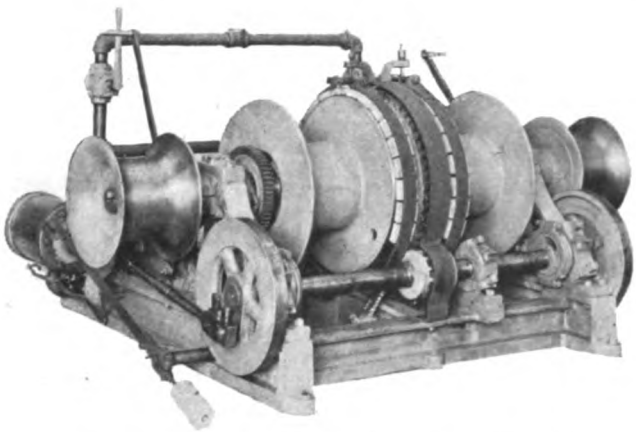

Fig. 3.—Lidgerwood Double-Friction Drum Winch

ture is provided for handling extra heavy loads, at which time the load is lowered by steam.

It is interesting to note that, with this arrangement, discharging can be carried on at both sides of the ship at once. For this two wire rope "whips" and two Manila "burtons" are employed. When discharging from one side only one wire rope whip and burton is used.

Another type of winch, which is fast becoming popular in the lumber trade on the Pacific Coast, is the single-keyed drum steam-reverse-valve winch (Fig. 2), manufactured by the Lidgerwood Manufacturing Company. These winches are aranged in pairs at the hatch and a single operator controls both winches. Wire rope is used on the drums, and the single operator not only controls the hatch whip, but also the burton. These winches are fitted with one winch head, which may be used with Manila rope if desired. The steam reverse valve is of special design and construction, giving perfect control of the load both in hoisting and lowering. There is but one lever for controlling each winch and the operator holds these. The load is lowered by a downward thrust of the lever and is hoisted by an up-pull on the lever.

While it is always preferable to have two single-drum winches at a hatch, on some steamers there is not sufficient deck space. Under these conditions a double-friction drum winch, as shown in Fig. 3, may be used at each hatch. These drums are arranged side by side, with gear between, and in addition there are two winch heads on the outboard ends of the drumshaft. This arrangement provides the same number of drums and winch heads as in the case of the two single-friction-drum winches, but requires two operators.

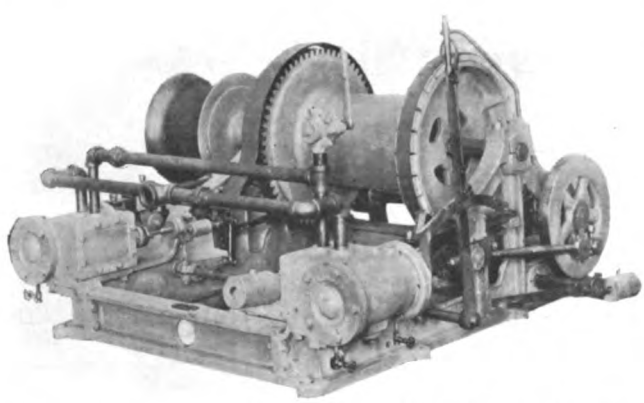

Fig. 4.—Arrangement of two Lidgerwood Single-Drum Reverse-Link-Motion Winches

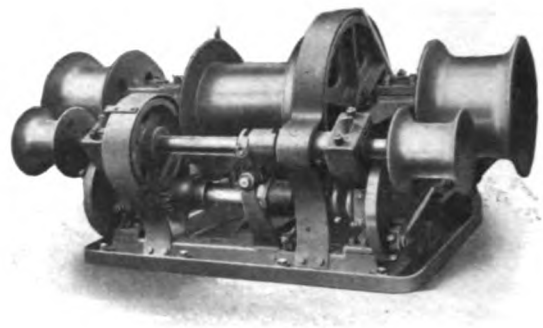

Fig. 5.—Hyde Cargo Hoisting Winch

In cases where a friction-drum winch is not desirable, two single-drum reverse-link-motion winches may be used, as shown in Fig. 4. It is possible for one man to control two winches of this type, while it requires greater effort to throw the links than to operate a steam-reverse valve. For this reason this type is not ordinarily used where one-man control is required.

The cargo winch illustrated in Fig. 5 is manufactured by the Hyde Windlass Company, Bath, Me. It is compound geared, fitted with link reserving gear and friction bands are fitted on drum for lowering heavy loads.

Electrically Operated Ships' Winches

While electrically operated ships' winches are not as yet in extensive use, there is a great deal of interest in the subject, and it is the belief that the day is not far distant when all of a ship's auxiliaries will be electrically operated.

In this connection it may be of interest to note that the steamers *Minnesota* and *Dakota*, of the Great Northern Railway, which were built about 1902, were fitted throughout with electrically driven ships' winches supplied by the Lidgerwood Manufacturing Company. Each of these ships had forty-eight single-drum winches, with which the load is lowered by reversing the motor and controlling the speed by a band brake on the drum.

Steering Gear

The first steam-steering engine built in this country was produced by the Lidgerwood Manufacturing Company, New York, and was of the drum type. A drawing of this steering gear is shown in Fig. 3. The steering engine to-day of this type is only a refinement of the details of the first steering engine built in 1886.

Other types of steering engines have been developed by

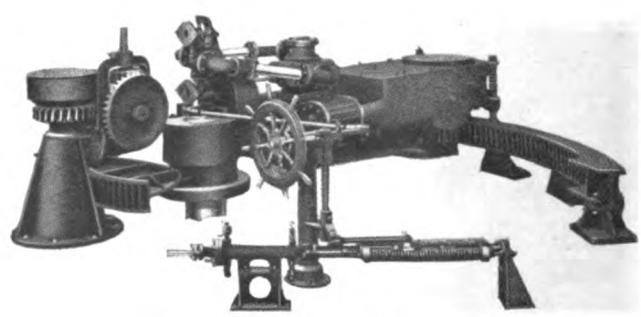

Fig. 1.—Brown Patent Steam Tiller

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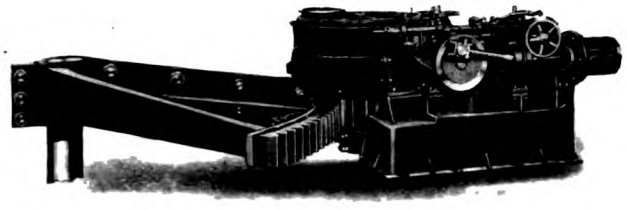

Fig. 2.—Hyde Steam-Steering Engine With Quadrant

the Lidgerwood Manufacturing Company, such as the screw gear, with telemotor and combined hand and steam gear.

The steam tiller illustrated in Fig. 1 is made by the Hyde Windlass Company, Bath, Me. The engine carried on the tiller arm drives a pinion engaged in a rack which is secured to the deck. The worm gear driven from the engine is fitted with an expansion clutch which can be so adjusted as to slip when there is undue strain on the rudder, and this prevents any injury to the rudder or steering gear. The valve of the engine is fitted with a patent automatic check valve so designed that steam is shut off immediately when engine is at rest.

The quadrant type of steering gear illustrated in Fig. 2 is another form of steering gear direct connected to the rudder stock. In this case the quadrant swings and the engine is securely bolted to the deck. The worm wheel of the engine is fitted with an expansion clutch the same as in the steam tiller above described, which slips and prevents injury to the steering gear on the rudder.

A steering gear much used for small vessels, where not

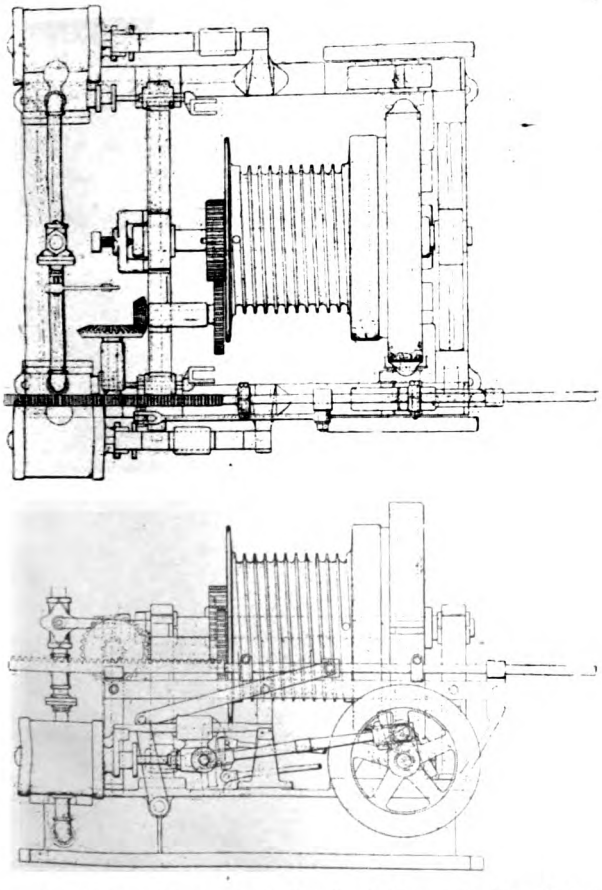

Fig. 3.—Steering Engine, built by the Lidgerwood Manufacturing Company in 1886

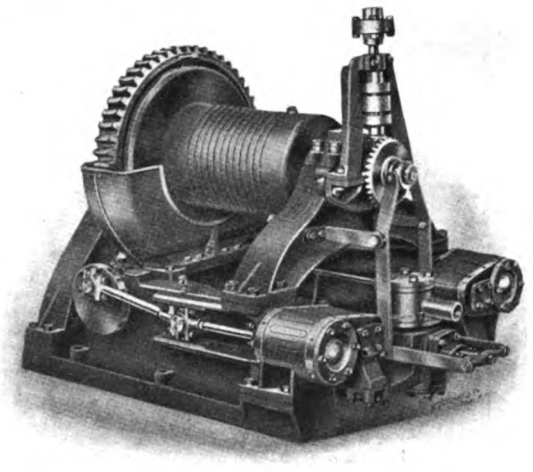

Fig. 4.—Hyde Steam-Steering Gear for Small Vessels

located in close proximity to the rudder stock, is the drum steerer illustrated in Fig. 4. Chains from the drum of this engine lead aft, connecting to the tiller rods or chains.

For a means of transmission between the pilot house and steering engine the hydraulic telemotor is the most approved type.

Marine Salvage Operations

In a paper recently read at a meeting of the Institute of Marine Engineers, in London, Mr. Robert Wright gave a brief description of the various apparatus used and of the different methods followed for salving ships under a variety of circumstances. In the matter of pumps, he stated that those almost universally adopted by salvage engineers were of the direct-driven centrifugal type; they occupied less space and could raise a larger quantity of water in less time and at smaller cost than any other kind of pump. Their principal recommendation from a salvor's point of view was the absence of all valves and contracted passages, which were liable to choke up at the most critical times. The vertical boiler and steam-driven pumps had now been to a large extent abandoned in favor of centrifugal pumps driven by oil engines. The lift of a centrifugal pump, however, was a comparatively limited one, being, under ordinary practical conditions, about 20 feet.

One of the greatest advances with regard to pumps for salvage work, the author pointed out, was undoubtedly the "submersible motor pump." For many years efforts had been made to enclose electric motors with different types of casings, so as to make them watertight and airtight, and the result had always been a failure, as the heat generated set up condensation and destroyed the insulation. The submersible motor made under the Macdonald patents had, however, effected a revolution in this respect, as the windings were insulated by a new process to stand continuous immersion in water.

In concluding his paper the author said it was a matter for regret that England did not have at the present time more and better equipped salvage companies. In his opinion sufficient energy and enterprise in the recovery of sunken and stranded ships had not been displayed, although at no time in the history of the country has there been such a necessity for men with good scientific training and practical experience to apply their talents to this task.

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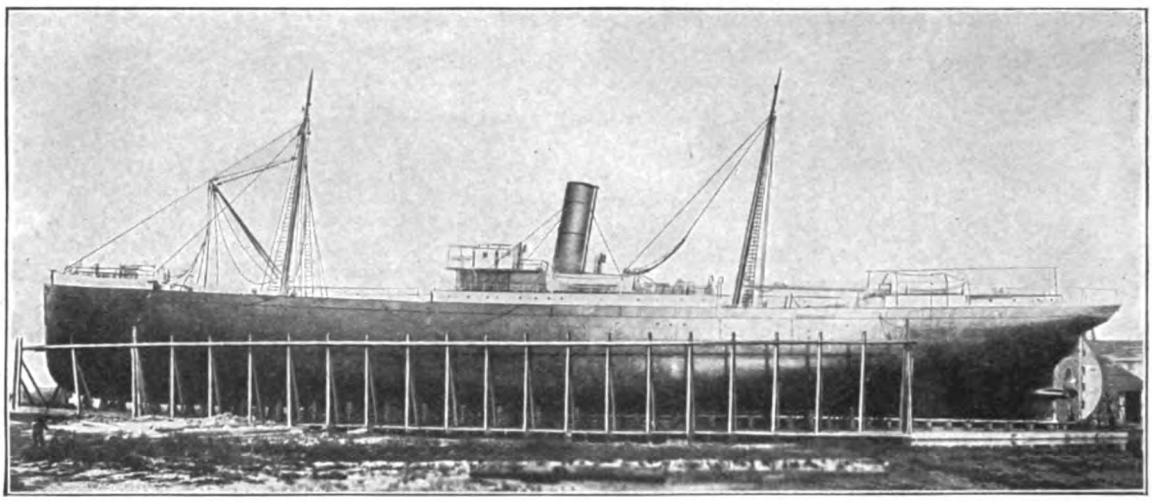

Fig. 1.—Steamship on a "Crandall" Railway Dock

Dry Dock Development in Twenty Years

Features Developed in Basin or Graving Docks, Floating Dry Docks and Marine Railways—Dry Dock Machinery

IT is interesting to note the advance that has been made in the engineering of dry docks during the last twenty years. Then, as now, dry docks in general were mainly confined to the three general types known as the graving or basin dry dock, the floating dry dock and the marine railway. A few other isolated types were in use, but scarcely any new docks of such kinds have been built since then, and some have gone out of use entirely. The general improvements that have been made in the three familiar types above mentioned, exclusive of structural details, are briefly as follows:

Basin or Graving Docks

In this kind of dry dock the general types of construction have remained about the same. Gates and pumping machinery are practically the same except in the matter of size, although the advent of the modern electric motor has greatly improved pumping equipment. The one notable improvement is the fairly general adoption of the bilge block system of supporting vessels.

The main impetus to this improvement was given by the United States Government when in 1892 it adopted the system of equipping battleships with docking keels under the bilges, with the definite purpose of supporting the ships by this means, instead of relying on side shores. The bilge block system had long proved its value in the case of commercial vessels.

The great advance in the matter of size is shown by

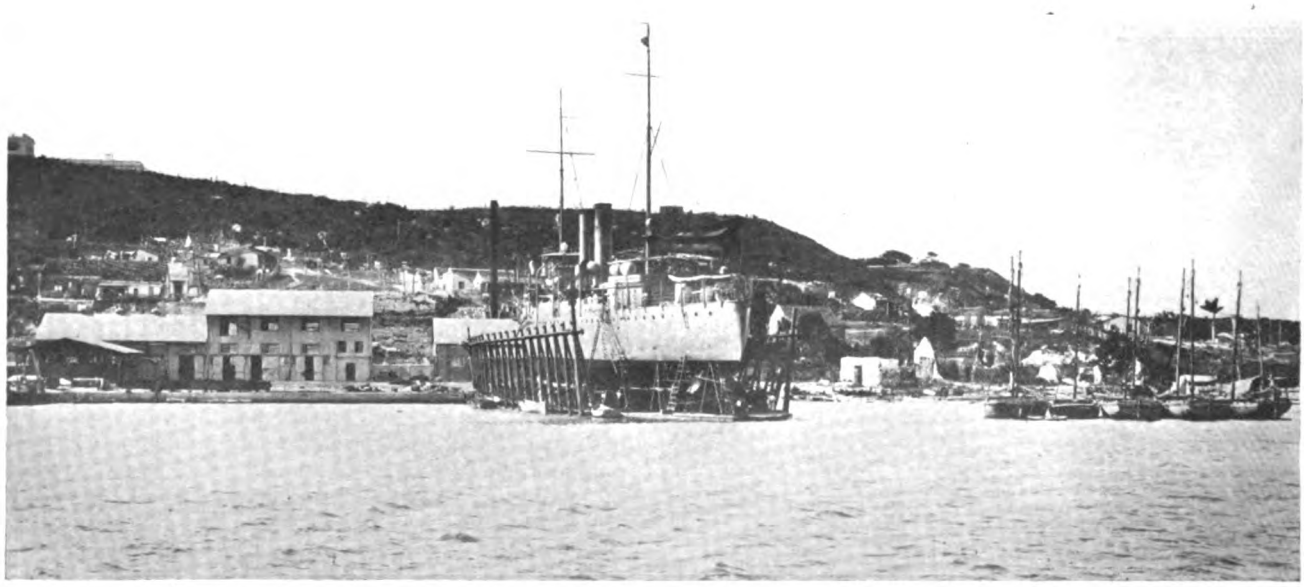

Fig. 2.—Warship Docked in Modern Marine Railway Dry Dock

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the fact that in 1896 a 600-foot dry dock was considered large, while to-day most new dry docks of this type are being built from 1,000 to 1,200 feet long.

Floating Dry Docks

Twenty years ago the floating dry dock was just coming into its own. At that time there was none of large capacity in America. In 1897 the 10,000-ton all-steel Havana dry dock of Clark & Stanfield's design was considered the last word in floating dry dock construction. This was followed quickly by other large floating docks in the United States and Europe. In 1900 was built the first all-steel dock in America. It was of the Clark & Stanfield type of 18,000 tons capacity, and was built for the United States Government. Previous to that all the floating docks in America were of wooden construction, and wood still remains the favorite material for such docks in this country.

The type of floating dock which at present bids fair to prove the best, at least in America, for docks of large size, is a new adaptation of quite an old idea, composed of a number of base pontoons built of wood connected to continuous steel wing walls.

That the floating dry dock has now fully emerged from its experimental stage is seen by the fact that the British Government has adopted it for its largest war vessels, and has installed at two of its most important naval stations steel floating docks of 32,000 tons capacity. These two dry docks are very complete, being equipped with complete machine shops installed within the watertight side walls. The German Government has gone one step further and has installed a similar floating dock of 40,000 tons capacity at Kiel. There is also one of 35,000 tons capacity located at Hamburg. The largest floating dry dock in America is located at Montreal, Canada. It is of the Clark & Stanfield type, constructed entirely of steel, and has a lifting capacity of 25,000 tons.

Practically all of these floating dry docks are fitted with the bilge block system of support.

Outside of structural details, the main improvements in floating dry docks are comprised in better methods of self docking, reduction of docking time by use of greater and better pumping equipment, and the control of all pumps and gates from central operating stations.

Marine Railways

Twenty years ago the modern marine railway was just beginning to be recognized. The European type, known as the "patent slipway," was a poor substitute for a dry dock, and has not been improved upon since that time, except in structural details.

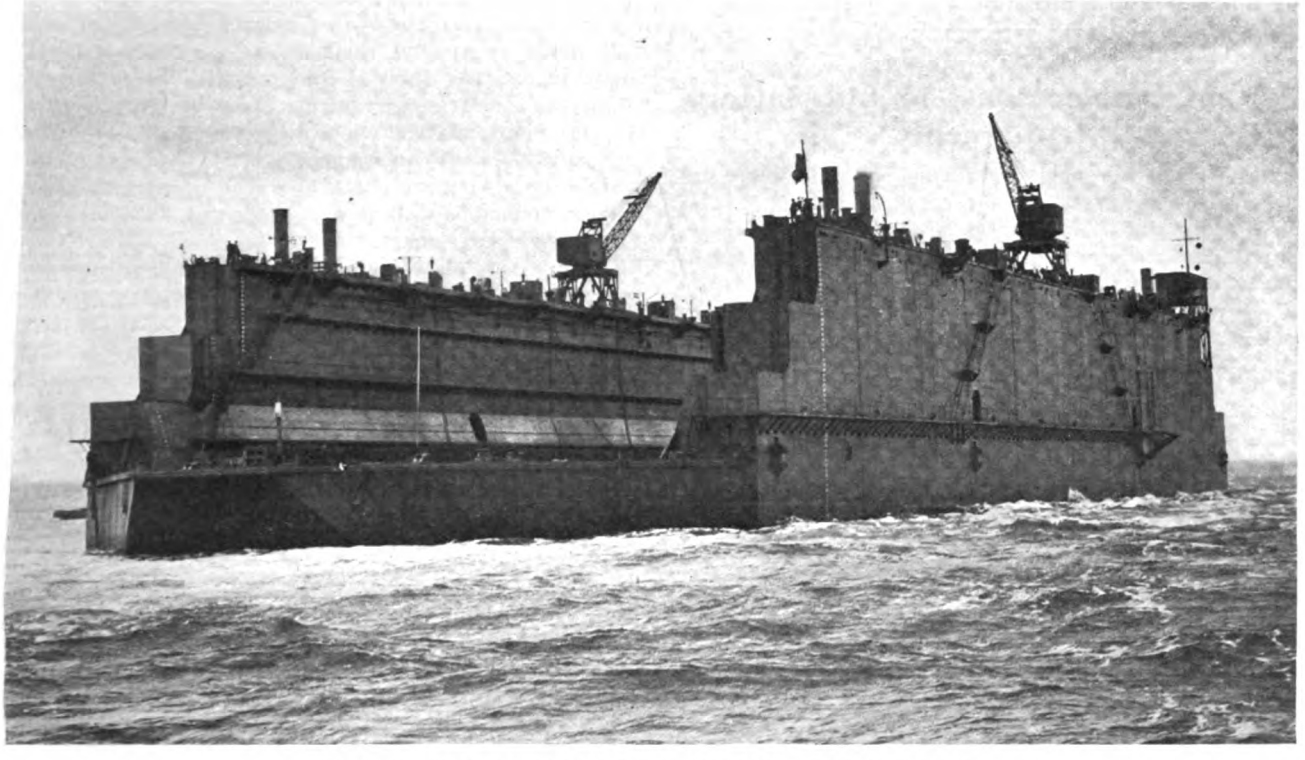

Fig. 3.—32,000-Ton Floating Dry Dock at Portsmouth Dock Yard

The old "marine railway" of America was even more crude than the European type, and little or no engineering experience entered into its construction. Foundations under water were largely a matter of guesswork. These conditions rightly led to the conclusion that the old type of marine railway or "slipway" was unfit to be considered a worthy dry docking means for vessels of any size.

There had, however, been several serious attempts made by one American engineer to produce a thoroughgoing dry dock operated upon the inclined-plane principle, by transforming the "cradle" so as to embody in it all the essential features of a thorough dry dock, and to secure the necessary "lift" by operating this dry dock upon an inclined track. This was the first attempt to produce marine railways upon the basis of good engineering.

This new type of marine railway soon became known as the "Crandall Railway," after the name of its originator. In 1896 there were but three Crandall railways in the United States, ranging from 1,200 to 2,000 tons capacity. There were two in Canada of 2,500 tons capacity, and quite a number of smaller ones. In 1900 a Crandall

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railway of 4,000 tons appeared, and since that time a large number have been built, ranging from 3,000 to 5,000 tons capacity.

This development has necessitated the production of greatly improved hauling machinery from the old single chain "horse power" hoist to the modern electric machine operating from four to twelve heavy hauling chains. Upon one of these modern railway dry docks a 5,000-ton vessel is picked up practically as it floats in the water and is hauled up and dry in thirty-five to forty minutes.

Such a work necessitates careful and thorough engineering from the foundation beneath the track to the last detail of the hauling machinery. Thus, while the modern marine railway is but now coming into its own, it represents a great advance in its engineering during the last twenty years.

Recent Developments in Life-Saving Equipment

With the considerable improvements in lifeboats and rafts with which vessels are now supplied, additional safeguards in the way of efficient life preservers have been developed in recent years which are of particular interest to passengers and other sea-going people.

It is well known that conditions sometimes occur in cases of disaster at sea where boats and rafts are for various reasons not available. In some instances they cannot be lowered on account of the vessel inclining too much, or they may be damaged. Even when they can be lowered they sometimes capsize after lowering, or become swamped. Passengers and crew entering boats at sea in emergency need efficient life preservers with which they can move about easily so that they will be ready for any accident that may occur in launching the boat or after it is in the water.

Putting on a Universal Ilanasilk Life Preserver

The difficulty of adjusting the ordinary cork life belts and their liability to get out of place, and also their tendency to throw a person on the face in the water is well known. To overcome this, a life preserver has been introduced that is soft, comfortable, easily adjusted, fits adult or child, holds head of wearer out of water even if exhausted or unconscious, and will support the heaviest person for an indefinite length of time. This type, known as the universal Ilanasilk life preserver, has been adopted by the United States Steamboat Inspection Service after thorough tests and extensive demonstrations.

Universal Ilanasilk Mattress and Pillow in Use as Life Preserver

The Ilanasilk filling material has been developed by the Robinson-Roders Company, of Newark, N. J., and is manufactured by that company from the best Java fiber, imported direct to the factory. The Universal type of life preservers has been developed and patented by Lieut. S. P. Edmonds, United States Coast Guard, retired.

The British and Canadian Governments adopted these equipments as soon as their merits were demonstrated. The United States Navy is equipped with life preservers, pillows and mattresses requiring many hundred thousand pounds of this material supplied by the Robinson-Roders Company. Other Government vessels, yachts, motorboats, canoes, etc., are now using such equipments, and a suitable swimming belt is also made for swimmers and those learning to swim.

The pillow is made in the form of a most efficient life preserver as well as a comfortable sleeping pillow, and the mattresses are so constructed that they may be very quickly secured together in the form of rafts. As each berth must be equipped with some kind of pillow and mattress, every passenger has his life preserver pillow and safety mattress at hand. In such disasters as those of the *Titanic*, *Lusitania* and *Empress of Ireland* such equipments would mean all the difference between drowning and rescue. Their wide adoption for use on Government and other vessels marks a distinct step in advance for life-saving equipment in recent years.

Towing Suggestions—Hawsers and Lines

IN deep-sea work the heavier the line the easier the towing. A decided dip or catenary curve gives the same advantage here as does a long slope of cable with a vessel riding at anchor. The sagging bight acts as an elastic spring, preventing variations in the tension—as from the action of heavy waves striking against the bows of the tow—from being thrown on the line in sudden jerks. The amount of sag depends on both the length and weight of the line.

The dip in no way reduces the line's tension required for steady towing. At the same time it does furnish an

Fleet of Barges in Tow

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elastic connection by which the forces arising in the seaway are absorbed gradually.

Manila, on the whole, is undoubtedly the most satisfactory line which can be used, being heavy enough to give a good dip, not too heavy for convenient handling, strong enough and with plenty of buoyancy. Should the manila line prove too light to absorb the shocks of the seaway, a good-sized kedge anchor can sometimes be hung upon it to increase its weight. This deepens the sag and thus gives a larger factor of safety against jerks.

The length of towline needed varies naturally with circumstances. It is far batter, however, to have too much than too little. The use of a margin of safety which seems unreasonably large may result in very comfortable security from vexatious accidents and delays.

It is quite important, when towing in a seaway, to keep the ships as nearly as possible "in step" with the waves. A line should be used of such length that the two ships will meet the waves and ride over them together.

If the length of line puts one vessel in the trough of the sea when the other is on the crest, the line will slacken for a moment and then tauten out with a sudden jerk. If, however, they meet the waves at the same time, the tension on the line will remain comparatively steady.

The wave lengths of a sea are usually approximately uniform at any given time, being dependent partly on the velocity of the wind and partly upon the distance over which this wind has acted in piling them up. For this reason it should not be difficult to arrange the line as above, by either heaving in or veering away the cable on the tow.

Of course, when towing for a long time or over a great distance, extreme variations may be found in wave lengths. The inconvenience of changing the length of towline to meet this condition may more than offset the advantage gained. It is always worth while, however, to start with conditions right, on the assumption that they may continue right.

Correspondence Instruction Among Sea-Faring Men

An Aid for Applicants for Marine Engineers' Licenses—Promotion of Students in the Navy and Merchant Marine

BY CAPTAIN E. K. RODEN *

WHEN the system of instruction by correspondence was first started twenty-five years ago people were somewhat dubious about its character and practical value. At that time educators and men interested in educational matters predicted the attempt to teach by mail would prove a flat failure, and for many years an adverse feeling prevailed against the system. The International Correspondence Schools of Scranton, Pa., founded in 1891, has clearly demonstrated the practicability and success of teaching by correspondence the theory of the trades and the engineering professions, and now after twenty-five years of hard labor has proved beyond question the utility and value of its system, which has become very extended and deservedly popular and has received unqualified endorsements from leading men in all stations of life, trades and professions.

Among all achievements of the I. C. S. in training men for promotion and increased earnings, few surpass in importance the success attained by men that follow the sea. Thousands of men in the deck and engine departments of the navy and the merchant marine have availed themselves of the courses in navigation, marine, electrical, gas and steam engineering offered by the I. C. S., and by actual figures 85 percent of these men have made good.

This speaks well for a system which twenty-five years ago entered its experimental stage. At that time ambitious oilers, watertenders and firemen in the navy and the merchant steamer, who desired to become some day full-fledged marine engineers, had little or nothing to depend upon for assistance other than their practical experience. The brightest of aspirants for an engineer's position progressed very slowly, compared with what may be accomplished by the average man to-day by means of carefully prepared correspondence courses.

Technical education was called for as part of the qualifications of an expectant engineer. So, many otherwise good men were obliged to be content with subordinate positions, or, to say the most, with positions calling only for the lower grades of engineer's licenses, because of lack of education. Conditions have changed since then. Now educational opportunities actually go to those who harbor a desire to become something more than a subordinate, and it creates a desire in those who had no thought of advancing. The I. C. S. system is solely responsible for this changed condition of affairs. It appeals to the man at the foot of the ladder to climb and do better.

There is no excuse now for an ambitious man in the engineers' department of any steam vessel to remain in a subordinate position any longer than the law calls for. He can study "off watch" while putting in the required sea service, and at the end of that service he will be prepared to pass his license examination. Incidentally, it may be stated that I. C. S. courses are infinitely more than a mere preparation for examination. They teach the elements and underlying principles of the profession and show how to apply them. Preparation for an examination does not do that. A candidate wants more than a license; he wants the real knowledge that the license is presumed to represent. During its career of twenty-five years the records of the I. C. S. show that until October 1, 1916, it had enrolled 11,427 students in the navy and 16,103 students in all classes of merchant vessels. Included in these figures are men who now serve as engineers, captains and deck officers, but who previous to taking up courses served before the mast. That I. C. S. courses have proved a benefit to enlisted men in the navy is shown by the fact that of the 42 warrant officers who up to this time have been appointed to the rank of commissioned officers, 33 were I. C. S. students.

Studying by correspondence is no lazy man's job; it requires grit, perseverance and a firm desire to get ahead. But to those who really want to dig in and do their share in helping themselves, there is an avenue open through correspondence instruction by which to reach their goal.

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THE TERMINAL SHED AND WAREHOUSE

Municipal Piers at Port of Seattle, Wash.

Fig. 1.—Terminal Sheds at Seattle, Wash., Showing Dray Road and Car Placement Tracks

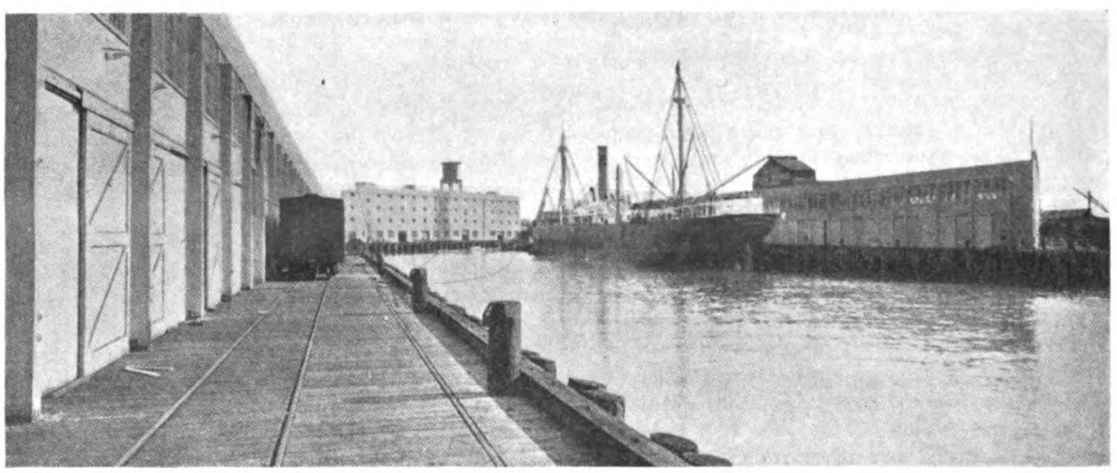

Fig. 2.—Car Track and Crane Rail Between Shed and Edge of Pier at Seattle Piers

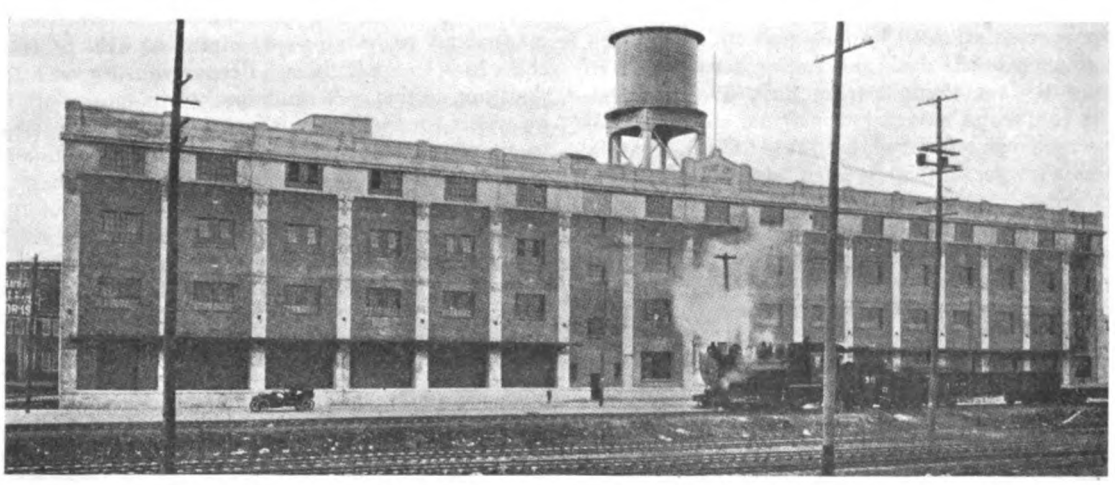

Fig. 3.—Reinforced Concrete, Four-Story Terminal Warehouse at Seattle

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Fig. 4.—Pier Sheds, Marginal Way and Car Placement Tracks at Seattle Terminal

The Terminal Shed and Warehouse

Comprehensive Discussion of Pier Shed and Terminal Warehouse Design—Shed and Warehouse Capacity—Details of Construction

BY H. MC L. HARDING *

IN terminal engineering there are certain rules and principles which in general can be adopted and adapted to new work with advantage. Like all similar engineering rules, and especially in the marine field, they represent the standard practice of the best terminals, at the ports with the best facilities.

A careful study of many marine terminals, chiefly abroad, shows not only a similarity in design, but a tendency and positive trend to follow such plans in all new work.

Example of Standard Practice

To illustrate and give one example, the general practice on the Continent in Europe has been to set the sheds back some thirty-five or forty feet from the edge of the quay and pier, with railway tracks between. These railway tracks should be set flush with the pavement, to permit of the use of this intervening space by auto trucks, which have become an important element in port development. This space is spanned by gantry cranes.

The practice at Liverpool and in the United States was to have the shed walls within about six feet of the edge. This is even now recommended in some civil engineering handbooks published in the United States.

Change at Liverpool

In July, 1914, the chairman of the Mersey Harbor Board (Liverpool), as per the United States Consular Reports, stated that as the practice of setting back the sheds was much in vogue on the Continent, being the almost universal custom, although it was a considerable departure for Liverpool, they would adopt it for the new quays and piers about to be constructed.

Latest American Practice

Since then the same plan has been adopted in the United States at Seattle in the latest developments (see latest views and reports); at Montreal, from the last report of Hon. W. G. Ross, President, Harbor Commissioners; at New Orleans, piles are being driven outside of the present quay, and railway tracks are there being laid; and at the new pier of the City of New York, recently leased by the Luckenbach Steamship Company in Brooklyn, in which case the lessee, against great opposition, insisted upon and secured the same innovation; at Beaumont, Tex., Galveston and elsewhere the same rule is being followed.

The above is only cited as one example of many, as indicating how the practice of the most successful ports which have had the largest mercantile marine has become a rule of terminal engineering.

By the adoption of this design greater speed and economy are attained, and the elimination of the dock or ship winch congestion.

Even more striking illustrations could be given from the design of substructures of quays and piers, of the co-

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THE TERMINAL SHED AND WAREHOUSE

Construction of New Marine Terminal at Beaumont, Tex.

Fig. 5.—Vessel Moored at New Beaumont Terminal

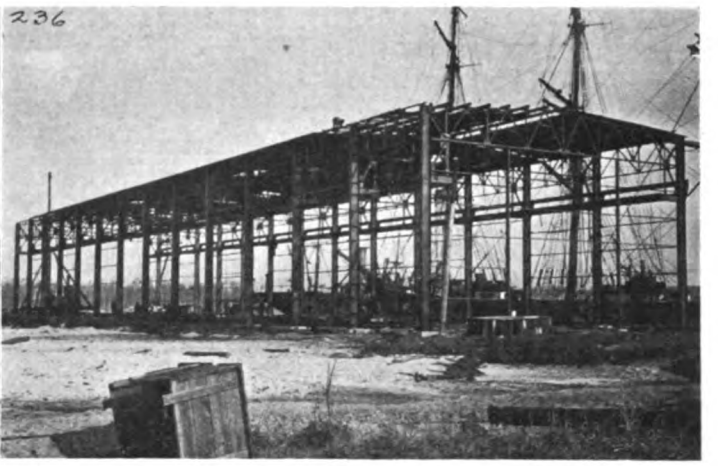

Fig. 6.—Erecting the Shed, Showing Type of Construction

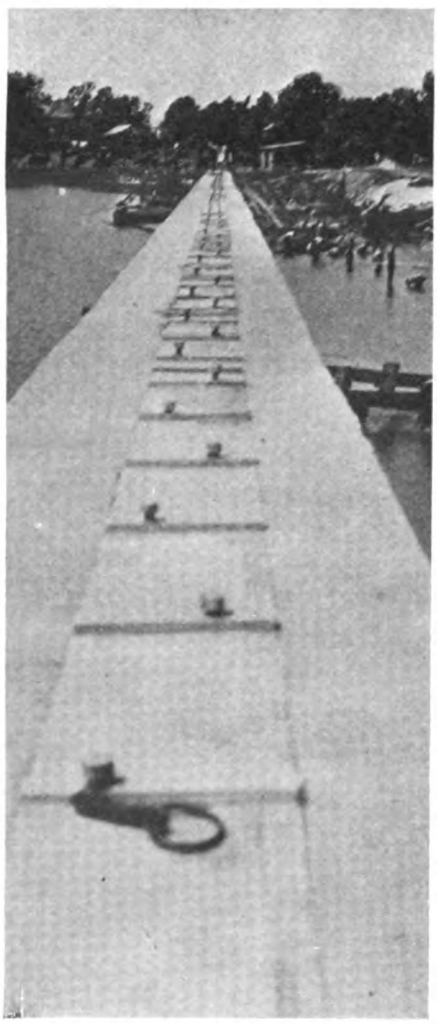

Fig. 7.—Top of Quay Wall

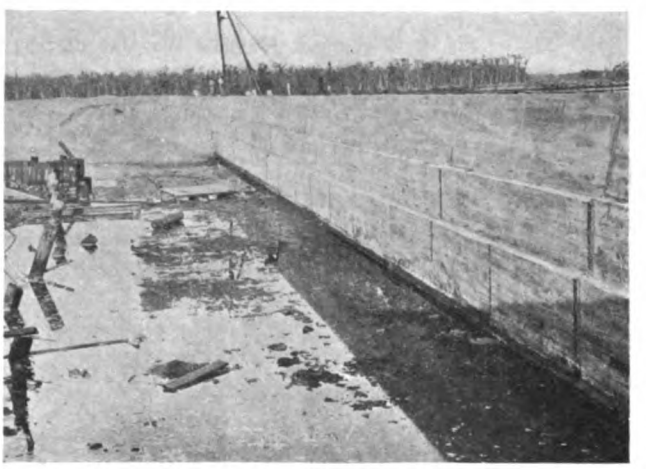

Fig. 8.—Rear of Quay Wall, Showing Area to be Filled with Sand Pumped from the River

Fig. 9.—Face of Concrete Quay Wall Protected by Oak Fenders

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ordination between cars and vessels, in the plan design and material of the superstructures, and still more forcibly in the adoption of mechanical appliances to freight handling instead of depending upon manual labor.

This present paper will refer chiefly to terminal sheds and warehouses.

Distinction Between Sheds and Warehouses

Their design, arrangement, dimensions, location in reference to each other and the whole terminal and costs are herein briefly described. It is hoped that the results of the study of many terminals may be of service to others, who are not hampered by tradition, and who, as terminal engineers, are designing similar terminals.

The following is not intended to be a specification or a complete and final description, but to indicate certain terminal principles pertaining to terminal shed and warehouse problems.

The Shed

The terminal shed differs from the terminal warehouse in its functions, in its design and construction.

Speed Capacity

In the shed, the feature most desired is speed of operation, whereby there will be avoided interference with freight or cargo movements, and the elimination of all possible points of congestion.

The ship must be discharged and loaded with the greatest rapidity, as its charter value may be a thousand dollars or even more per day.

Berthing Frontage

The most valuable portion of a terminal is its linear berthing frontage. This frontage may be said to be the controlling factor as to the capacity of the terminal. If a terminal should cost $1,000,000 (£205,000), and by means of design and facilities twice the number of ships can be discharged and loaded in a given time, then the investment of $1,000,000 (£205,000) would be the equivalent of an investment of $2,000,000 (£410,000) with a frontage not so designed and equipped. For miscellaneous or package freight the shed often is the place of congestion.

As the inbound cargo is generally of many marks, which must be assorted, distributed and tiered according to these marks within the shed, the necessity of free and quick movements is evident, as well as the avoidance of anything which may cause delay in obtaining the essential speed-capacity. Economy follows speed.

No Intermediate Columns

The terminal shed should be free from intermediate supporting columns, which, besides wasting much floor space, obstruct the movements of distribution, causing the loops of freight travel to be greatly extended.

If a pier be very wide, it is preferable to have two sheds upon it with tracks between, besides the tracks between the shed and the edge of the pier.

The shed should be well lighted from outside, and for the high tiering about double the height of the usual type of marine shed.

One High Story of More Capacity Than Two of Usual Height

By thus increasing the clear vertical space below the girders to thirty feet, the shed, though of one story, will have more capacity than that of two stories, each of the usual height of fifteen to eighteen feet.

When the shed is of two stories, to store freight on the second story would require the installation of the interfering columns in the lower story to support this weight.

There would also be the loss of holding space which would be occupied by the second-story floor and girders. The number of foremen and inspectors would be doubled for two floors.

The upper story for inbound cargoes and the lower story for outbound cargoes, or vice versa, has not been successful.

With the high one-story shed there is better daylight, and hence less thefts and idleness.

Five hundred-candlepower tungsten lamps are suitable for night lighting.

High Tiering

Instead of the usual five feet tiering of the cargoes, twenty feet tiering by mechanical appliances is the rule—that is, while on two stories there are only five feet plus five feet, or ten feet, with a high one-storied shed tiering twenty feet twice as much cargo can be placed within the shed.

A two-story shed also may cost on the average twice that for the one-story shed. This is especially true taking into consideration the increased cost of the wall foundations which are near the water's edge.

The Shed Function—Temporary Holding

The function of the shed is only for temporary holdings, not long storage. After forty-eight or seventy-two hours' holding, the cargo must be removed to provide room for other cargoes from or to other ships.

The floor should be clear for the new freight.

Continual Operation

There are continual movements in loops of freight in, or cargoes out, all day and often nights and Sundays.

This freight handling is often continuous without cessation, and is only surpassed in uninterrupted operation by railway transfer stations.

Shed Holding Capacity

Larger and broader ships are now being constructed, therefore there should be a corresponding larger shed holding capacity.

The custom has been to make the shed about one hundred feet less than the longest ship expected there to berth, or one hundred feet less than the berthing frontage, and with a capacity equal to the cargoes of two such ships, or for one inbound and one outbound cargo.

The next ship along the quay would have its shed, there being as many sheds as ships or berths.

To hold such a cargo of miscellaneous freight piling to the usual height of five feet would require a very broad shed; it is therefore necessary to tier to a greater height.

If the ship's length and berth be 600 feet of linear frontage, then the shed should be 500 feet in length and 80 feet wide. If the berth be 500 feet in length, then the shed should be 400 feet long and 60 feet or 80 feet wide. The sheds should be extended along the quay or pier with ample fire space between the ends of the sheds.

Assuming that two cargoes would equal 12,000 tons, then for package freight at 60 cubic feet per ton and allowing for the aisles and working space sufficient to bring the space per ton equal to 65 feet, then the cubical content would be $12,000 \times 65 = 780,000$ cubic feet.

A shed 500 feet by 80 feet by 20 feet (30 feet high) would have a holding capacity of 800,000 cubic feet, about 10 feet being allowed above the tiered cargo.

If piled only 5 feet high, the economical height for manual labor, the dimensions of the shed would be 500 feet by 320 feet by 15 feet, thus requiring an excessively large floor area and a shed cost of over three times as much

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and operating costs of three or four times as much, due to the greater distance of freight conveying and the necessity for more manual labor and less mechanical movements. The cubical space per ton varies according to the nature of the cargo.

CONGESTION MAY DOUBLE TIME AND COST OF HANDLING

A block of the freight movement or congestion at any one point may double the time and cost of handling. Congestion often causes rehandling, breakage and long delays.

SPEED CAPACITY

Speed, speed-capacity, is the most important condition to be attained within the shed walls, as well as at the whole terminal, and this fact must always be uppermost in the terminal engineer's mind.

SHED LOCATION

On a quay or pier the shed should be set back from the water frontage, and parallel thereto from 35 to 45 feet, with two or three railway tracks in front and also at the rear of the shed; the front tracks chiefly for outbound cargoes and the rear tracks for inbound freight.

GANTRY CRANES OUTSIDE

These tracks with cars should be spanned by specially constructed gantry cranes of light weight of two tons capacity and low first cost. The number should be one for each 100 feet linear frontage. Every fifth crane may be of five tons capacity.

SHED MATERIAL

The sheds should be of steel, not concrete; fireproof, 60 feet to 80 feet wide, and equipped within with cross traveling cranes with adjustable loops for the mechanical quick assorting, easy distributing and high tiering.

Any little settling of the shed columns can be easily remedied by shimming, which would not be easily done if the building and the columns are of concrete construction.

It is often desirable to add other appliances or supports in the shed or to make changes. This is difficult when the building is of concrete.

DETAILS OF CONSTRUCTION

The sides and ends of the shed should be of galvanized corrugated metal, to be carefully painted inside and out, or asbestos covered.

The ends of the sheds may be of pleasing architectural appearance. A flagstaff, roof scuttles and ladders should be provided.

While the roof of the shed may be of different kinds of material, tar and gravel roofs are satisfactory.

The floor of the shed is of concrete 6 inches in thickness, in 12-foot squares for expansion, and surfaced with 1½ to 2 inches of asphalt.

The toilet rooms should preferably be within the sheds and at the ends, for easy supervision by the foremen. The walls of the toilet rooms should be coated to the height of seven feet with asphaltic or bitumen paint to prevent rusting, so that they can be easily cleaned with the hose.

There should be small rooms at the ends of the shed by the side of the end doors for the door keepers and receiving and checking clerks.

The water main may be on the side or center of the shed if overhead, and of sufficient size for the sprinkler system. Meters within and fire hydrants just outside the sheds should be installed.

For a terminal of several sheds and warehouses, there should be a separate office building for administration, engineering and drafting, and not have such offices occupying valuable shed space. The warehouse also should not be open to all who must have access to the offices, therefore the general offices should preferably not be in the warehouse.

The shed may be stated to be a place designed for the quickest freight handling, chiefly inbound, and for short temporary holding, but not for long storage.

The shed is open to draymen, shippers, consignees, their clerks and messengers and many others, and is the scene of the greatest and most feverish activity.

THE WAREHOUSE

With the warehouse all is different; where the shed is full of noise and speed, the warehouse is quiet and deliberate.

By means of machinery the merchandise, after about seventy-two hours, is swung by cranes from the floor of the shed to any of the floors of the warehouse, where it may remain for a month or a year, or as long as the storage charges are paid. Speed of movement is not so essential, and all the functions are different from those of the shed.

There must be full protection against fire, theft, or any possible injury to the contents, and no one can enter the warehouse without a permit.

WAREHOUSE CONSTRUCTION AND DESIGN

The warehouse, instead of being of steel, is of thick, reinforced concrete with wire glass windows. While it is of the same length as the quay shed and parallel to it, with a width of 80 feet, if the location permits, the number of stories and the internal arrangements vary, often depending upon the nature of the principal commodity to be long stored.

All steel sheds, except in respect to length, are much alike. In the warehouse this is not so, as there might be one arrangement for cotton, similar to Manchester, England, another for general merchandise, as at Bremen or Mannheim, another for perishable goods which require cold storage, and others where an equable temperature is necessary, as at Seattle, Wash.

The points of similarity, though not fixed, are the width and length. For general merchandise the number of stories would be either four or six, six stories giving the greatest number of cubic feet for the least investment. Material, as stated, should be reinforced concrete.

The building should be constructed on most firm foundations, as any settling would be of great detriment to the appearance by causing unsightly cracks.

SHED COSTS

The cost of steel sheds during the past three years has so greatly increased that any figures made previously would have but little value at the present time. On account of the almost daily variations in the price of materials, transportation and labor, there must necessarily be wide margins in general estimates. It would, however, be safe to average the cost of high steel sheds between 3½ and 4¼ cents per cubic foot, outside measurements. To this should be added the price of the machinery and plumbing and other appliances.

There will be no partitions, only one large open space, and being of simple construction, will be of proportionately low cost. The dimensions of each shed would be: For large ocean terminals, 500 feet long, 80 feet wide and 30 feet to 35 feet clear height below the girders, with one span; for inland ocean terminals, the dimensions may be 400 feet by 60 feet by 30 feet, and for inland river barge terminals, 300 feet by 60 feet by 30 feet.

(To be concluded.)

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Marine Machine Shop Equipment

Tools Ranging from the Smallest and Finest to the Largest and Heaviest Required in Shipyard Machine Shops

BY W. D. FORBES

FROM stem to rudder, from keel to mast head and from bulwark to bulwark is a space which has to be filled with a multiplicity of articles which in numbers and variety cannot be found save in a ship. From the delicate setting of a chronometer jewel to the ponderous, bulky, rough anchor there is an immense range of work requiring machine tools.

Of course, all articles aboard ship are not produced in a shipbuilding establishment. The shipyard does not make chronometers, and rarely, if ever, anchors. The work has to be differentiated, yet in a shipyard there must be tools which remove material ranging from the fine dust from an emery wheel to the huge chips which are stripped from the heaviest forgings.

Routing of Work

We have heard a great deal about what is known as the "routing" of work, which merely means that care must be taken to start the rough material as one end of the shop, machining it as it advances, until it leaves the other end of the establishment, without retracing its steps, a finished product ready to erect or place in position. In ship work this becomes a matter of prime importance, as a large percentage of the machinery built is very heavy and its transportation from machine tool to machine tool is an expense which must be seriously considered.

This transportation demands cranes and these have been brought to a marvelous state of perfection by the introduction of electric drive.

This idea of "routing" is a little complex to consider in shipbuilding, as there must be some retracing unless conditions are very peculiar. An ideal condition would be: A shipyard built on a peninsular, where on one side raw material is floated to the dock, started on its path of manufacture and delivered on the other side of the peninsular to the hulls on their ways. This would mean, of course, that the shops would lie parallel in their greatest length with the ways. In many cases shipyards have just grown and not been planned. Buildings have been added as necessity required and time and capital permitted. A shipbuilding plant which the writer has in mind was carefully planned, and in building, the original design followed did not adopt this idea but placed its main machine shop at right angles to the shipways, with the result that material has to be transported further than seems justified.

Laying Out the Work

Let us consider the production of the heavier machinery which goes aboard ship, disregarding entirely the hulls. First, all parts of machinery have to be laid out. It is customary, though in the writer's opinion a mistake, to allow the machine-tool hand to do much of this laying out, if not all of it, with the result that his machine tool is not making chips to its full extent. In order to lay out there must be provided some accurate plane surface from which to start. Such a plane surface should be of finished cast iron, set perfectly level and, of course, served by overhead cranes.

When the work is laid out it proceeds to the machine tool to be placed on centers or bolted to platens. The large machine tools required are not merely the enlargement of the ordinary lathe, planer or drill press, but they are quite often provided with means of doing work which does not usually belong to their particular class of tool. For instance, a large planer may have one of its heads fitted with a slotting attachment and quite often means by which drilling operations can be carried out. These features are valuable, as by them in many cases alinements are more accurately and quickly made than if the mass is removed and set up again.

It must be admitted, however, that a careful consideration of many of these larger machine tools has shown me that these special features have not been as carefully considered as they should have been. In one case a very large planer was fitted with a slotting head, the design of which was so weak that it simply nibbled off the material instead of taking a perfect cut. This lightness demanded great skill on the part of the machine hand in order to get true surfaces, and operations took an excessive amount of time. The same condition existed in the drilling attachment.

Such large tools, of course, are not carried in stock, as their cost runs into thousands of dollars. They are therefore ordered and quite frequently certain special features are demanded which must be made in a prescribed way which considerably hampers the machine tool builder. How far these special features should be carried is a serious question, yet it is merely a matter of some figuring to see whether they are advisable. Suppose we have a planer costing $30,000 (£6,150). It is primarily for producing plane surfaces, but if on the class of work to be done there is considerable slotting or drilling, the question is simply whether the slotting and drilling should be done in a tool of this price or whether the work should be removed to a tool of very much less cost and there carried out, thereby relieving the higher-priced tool of interest charges and increasing its production of legitimate work.

Surfacing

Broadly speaking, whether the reciprocating or turbine engine is to be produced the first work is that of surfacing, and from such surfaces all other work must be laid out. There is much work which is now being done on a planer (a reciprocating machine) which of late years has been done by a continuous rotary cutter with inserted teeth of high-speed steel. Such tools, it seems to the writer, have not come into their own and there is a field open to the machine tool builder who will give his attention and study to improving this class of tool.

Among men who have spent years in the shop can be found a prejudice against this class of tool, and this is so for two reasons. One is well founded, and that is that the builders of tools have not put as much material in the tools as they should, nor have they put it in the right place, with the result that some of the work has not come out as true as it should, and for the erectors to attempt to correct inaccurate machine work is a heartbreaking job, besides being an expensive and unsatisfactory condition. The second objection comes merely from the scratchy appearance of the finished surface. Although this should have no weight, nevertheless it does.

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The large lathes for marine work are too well known to require any special description and are pretty well refined, but it should be remembered that the high-speed steels of to-day admit of a greater number of revolutions and remove more material at one cut than formerly. It therefore follows that far greater rigidity and greater strength in the drive are required. These large lathes are also specially built and are not by any means stock articles.

As changes occur in the design of machinery special tools for such new designs must be considered; for instance, boring large cylinders for the reciprocating type of engine permits of a vertical tool being used and work of great perfection can be confidently looked for and is obtained from these. Sometimes the tools used are of the revolving table type of vertical boring mills. Here again slotting and drilling attachments are sometimes provided, but often the boring is done on a stationary table by means of a revolving vertical boring bar. This machine has the advantage of simplicity in boring proper, but is practically useless for any other operation save for a certain amount of facing, while the rotating table style of boring mill is available for a much larger range of work. In smaller sizes this type of machine tool has been most marvelously refined during the past few years, but the writer has been unable to see anywhere near a corresponding advance in its larger brother.

Boring Operations

To-day the steam turbine demands boring operations which require a far greater nicety than the earlier builders of this prime mover supposed. There are, no doubt, some who build tools for this work whose designs are unknown to me, but those I have seen were usually makeshift affairs which, while extremely ingenious, did not do the work with anything like the celerity or exactness which the importance of such work demands, either from the mechanical or commercial side. Nor have I seen any design for as rapid drilling of casing bolt holes as should be on the market.

The writer is rather a crank on the drilling of large holes and has found by many practical experiences that a pilot drill makes for great increase in speed of drilling. I do not mean by this, as one of my friends understood, that a 3-inch drill with a ½-inch drill fitted to its center and driven at the proper speed for a 3-inch diameter of drill will help matters, but that the ½-inch drill should be first used at its proper speed and then followed by the larger drill.

All large tools for ship work should, of course, have independent drive, as their great cost demands that they should be twenty-four a day workers as near as possible.

Grinding

The grinding operations, which not long ago were looked upon very largely as somewhat super-refined and very expensive, have proved themselves neither, but quite necessary and thoroughly economical. Certain classes of work, which years ago were filed to a finish and out of all concentricity with great labor and pride, are now quickly and accurately done by the grinder, and the end is not yet. We all dearly love a handsome finish and it has a commercial value in keeping up the pride, resulting in better attention of those in charge.

The tools previously referred to are used for the major pieces of ship machinery, but it will astonish many to see how gradually the size of machine tools required tapers down until we reach the small precision bench lathe with its accurate drawing-in chucks. These small tools are quite commonly looked upon as an unnecessary refinement in marine machine shops, yet they are an extremely economical machine tool. The system of drawing-in chucks, which originated with them, is now being extended to quite a large diameter, large enough, I understand, to take in 6 inches, although I have never seen anything as large as this. There is no reason, however, why the system should not be extended to any length.

The regular standard lathe can never be entirely replaced on account of its great range of work and simplicity of tool, yet the market has been furnished with tools of a class which will produce duplicate pieces accurately and quickly without the necessity of the expensive box and other special tools used heretofore on screw machines. In skilled hands this class of tool is coming more and more into use, even in jobbing shops. We usually connect screw machines with bar work, but the machines which I have in mind and have referred to will not only handle bars but, within certain limits, castings.

Portable Tools

There has been a class of tool introduced which has been made immensely valuable by the electric drive. These are of the portable class and can be most advantageously employed in doing work on large pieces of marine machinery, either before or after they are set in the hull.

A tool which I have often wondered has never been produced for large machine work is what may be described as a multi-spindle-independent-radial-frame drill. This is a pretty long hyphenated word, but its general idea would be this: a large platen capable of a movement after the style of a planer bed, over which would be built a girder which could be raised and lowered. To this girder would be swung four radial drills, independently driven. These drills could be moved across the girder so as to bring them into any position required, the piece to be machined, of course, resting on the platen. These drill spindles should be made stocky enough to carry a good-sized inserted tooth-milling cutter and on the verticals which support the girder other drills of the same class should be set for right angle work. Of course, each spindle would require a man to operate it, but there is a good deal of work which could be handled by such a tool.

It is not easy for machinery men unfamiliar with ship building really to understand what a large field there is now looming up for machine tools for shipyard use, and I have been rather surprised to find men connected with the machine tool building industry who have the idea that all ship work is rough and what the Scotchman called "one-eight part" was about as close a measurement as marine work requires. This is, of course, a great mistake.

The Machine Shop on Board Ship

All well equipped ships to-day carry on them quite a machine shop, consisting of at least a drill press, shaper and lathe. These tools are now electrically driven, which make them far more serviceable and convenient than heretofore. Here again is a large field for improvement in tools especially adapted for this use. Repairs at sea have but one idea in view—that is to make them as soon as possible. Cost for the actual job has no significance, therefore makeshifts and nibbling processes are perfectly admissible and unavoidable.

Many modifications could be made in the machine tools for ship use which would widen their range, thereby increasing their value; and with the outlook in shipbuilding to-day special designs for machine tools to go afloat are well worthy of the consideration of designers and machine tool builders.

Returning to the machine shop, the gallery design is

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very common. Under these and on them are placed the smaller machine tools of the plant. If under, then some means for easily moving and lifting material should be provided which would demand separate and smaller overhead cranes, as the work on the lower floor is usually quite heavy.

The tools that are placed on the gallery do such work as can be easily lifted in by two men. To my mind such an arrangement has serious objections and I would much prefer that the lighter machine tools should occupy separate buildings, which I would place at right angles and leading into the main shops. I have heard objections to this idea, the main argument being that the men who have often to fit the small work to larger pieces would be obliged to walk a considerable distance; but this argument I do not think holds, as a man would have to walk equally far to reach the stairway from the gallery, descend it, walk to the place where the fit must be made and then retrace his steps.

In the smaller tools the question of their drive is interesting, and my experience goes to show that grouping the machines and driving the group with independent motors is more satisfactory and economical than individual drives for small tools. It is quite possible that with the change in steam prime movers and internal combustion engines very radical modifications will have to be made in marine machine shop equipment, more so as the first of the prime movers gains in popularity, and undoubtedly the latter type will call for designs much modified from what can now be found in the machine tool market.

Two Decades of Pipe Threading

BY H. S. ASHMUN*

THE oldest known stock and die for threading pipe (Fig. 1) is a stock with hand-forged, solid handles. The dies, which are an integral part of the stock, are made from slices of round tool steel. The tool probably dates back to about 1850. About fifty years ago the square pipe die (Fig. 3) commenced to gain in favor, and as recently as twenty-five years ago it was almost universally used in power machines as well as hand tools.

Fig. 1.—Oldest Known Stock and Die

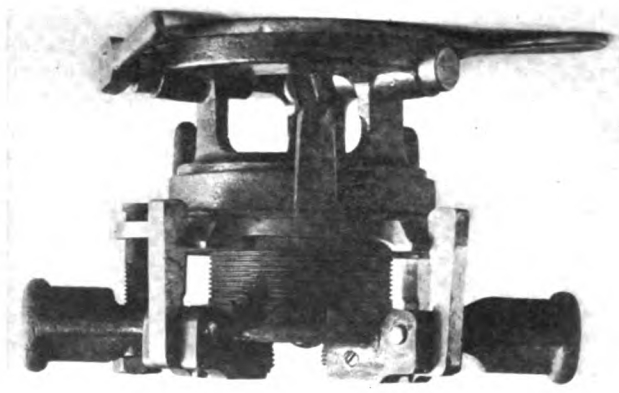

Fig. 5.—Modern Threading Tool, Embodying the Receding Principle

Not losing sight of the natural advancement which, in time, men bring to bear on all industries, we must not forget that in the threading of pipe the big forward step was caused by the introduction of steel pipe. Two decades ago the adjustable, or two-piece, die was coming into

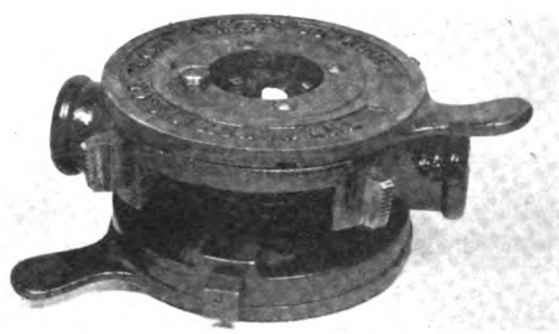

Fig. 6.—"Opening" Die Stock, or Quick-Releasing Type, With Adjustable Guide

* Manager Pipe Tool Department, Greenfield Tap & Die Corporation, Greenfield, Mass.

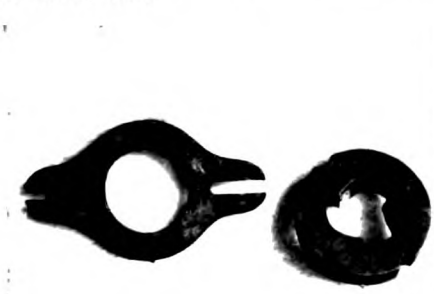

Fig. 2.—Name Plate and 1-inch Die from Oldest Known Stock and Die

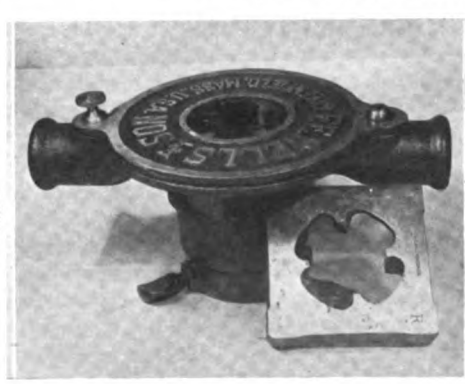

Fig. 3.—Square or Common Stock and Die

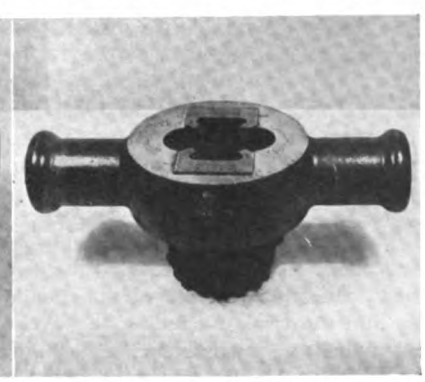

Fig. 4.—Split or Adjustable Stock and Die

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common usage and ten years later had nearly replaced the common or square die.

At this time steel pipe was attracting attention, and though more difficult to thread than iron pipe, it was making a comfortable market for itself. As is usually the case where a new condition is to be met, new ideas sprang up, each manufacturer trying to introduce a tool to meet this new condition.

Some increased the angle of cut, some introduced square or split dies with staggered teeth, while others turned to the manufacture of tools (Fig. 5) made on the now universally accepted receding die principle. This change in threading practice and unrest in the minds of users also opened the way for the round "opening" die stock or quick-releasing tool (Fig. 6).

Universal guides have to some extent replaced ring bushings and for a time it seemed that universal dies would replace dies threading only one size, but the variance in helical angles has re-established the single-size die in popular fancy. However, the users of universal dies had learned of the benefits that came from having multiple

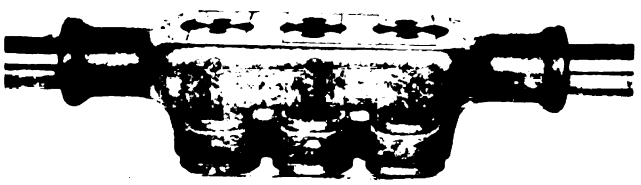

Fig. 7.—"Triple" Die Stock

sizes in one stock. This aided in the introduction of a new type of tool (Fig. 7), which has been nicknamed "triple" die stock. These tools are fitted with three sets of adjustable dies and meet the demand for several sizes in one stock without attempting to cut more than one size of pipe with each die.

The receding land principle also effected a change in power machine threading practice. Before its advent, when steam or other repairs were necessary, pipe larger than 2 inches was removed from place to be re-threaded on machines.

To-day through the use of geared receding threaders, pipe up to and including 12 inches can be threaded while in place by one man. Power machine threading has also seen the introduction of a unit motor which has made possible the mobility of larger machines. To-day it is a common thing to ship a 6 or 8-inch pipe threading machine, if equipped with an individual motor, to where the pipe is to be installed, hook it up with the now prevalent electric wires and thread the pipe on the job.

Progress in the Non-Ferrous Alloy Industry During the Last Two Decades

BY W. M. CORSE

The last two decades in the non-ferrous alloy industry have been marked by several distinct phases of development. First, the advent of the chemist and metallographist into the trade. Second, the exchange of information through trade journals and scientific societies. The oldest trade journal was started in 1902 and the two scientific societies, viz., the American Institute of Metals and the Institute of Metals of Great Britain, were founded in 1907 and 1909 respectively.; Third, the application of the knowledge gained to engineering problems and shop methods, both from a manufacturing and consuming viewpoint.

These three phases enabled information pertaining to the industry to be widely disseminated. This exchange of knowledge has led to many permanent advances and made possible many developments. For instance, aluminum is now a commercial article. Magnesium, tungsten, titanium and vanadium are well known and have important uses.

The effects of small additions to standard alloys have been studied and many new and valuable combinations have resulted.

The laboratory control of shop methods is an established fact. Its aids are the microscope, the pyrometer and other instruments of physical and chemical testing.

Such machines as the automobile, the aeroplane, and the internal combustion marine engine, have put such severe demands on materials of construction that a strong incentive has been given to the development of the scientific phases of this industry.

If the results of the next decade are in proportion to those of the last two, the non-ferrous alloy industry may be expected to contribute an important share of the world's development.

Oxy-Acetylene and Oxy-Hydrogen Welding and Cutting in the Marine Field

THE uses of oxygen and acetylene or hydrogen for welding and cutting, which had its commercial inception in this country about 1905 to 1906, has made rapid strides in connection with shipbuilding and its attendant industries, and is now proving a considerable factor in the development of the industry in this country.

The navy yards were the first to take up the use of the process to any large extent, and all of the large yards are now equipped with very efficient plants in which they are practically independent of outside supplies other than raw materials. They generate their own oxygen, hydrogen and acetylene, and compress the latter into dissolved acetylene tanks, so as to enable the process to be carried out anywhere in the yard or on vessels in the docks in the best and safest manner. This is such a characteristic of a navy yard equipment that welding equipments, including dissolved acetylene compression apparatus, have become known as "Navy Type Plants."

Not only are the yards equipped in this way, but the repair vessels *Dixie*, *Panther*, *Prometheus*, *Hancock*, *Vestal* and *Melville* are also equipped in a like manner, and it is to be expected that at some future date equipments will be carried on all battleships and cruisers of the navy, as it would enable numerous repairs to be carried out and the cutting apparatus would be quite a factor in removing wreckage. An instance of this is recorded in connection with the European war, where in an action before Belgrade the turret of a gunboat was struck and partly demolished so that the men inside could not get out, with the result that after the action was completed it was necessary to cut a hole in the turret to release them.

Up to this time the use of the welding process in marine construction has been largely confined to comparatively thin metals, excepting as far as repairs are concerned, small air tanks and parts of ventilating systems being welded in large quantities. The principal application of the process, however, is that connected with the use of oxygen for cutting steel. In the construction of the hull of a vessel, steel plates have to be cut very extensively

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into irregular shapes, which cannot be handled by the usual shearing machinery. This work, in the past, has been carried out by methods which included the extensive use of air chisels with which the metal was cut away bit by bit until the correct contour of the plate was obtained, and this department of a shipyard was an extremely busy one. Now, however, in up-to-date yards, this department contains only a few men who do this work by means of the oxy-acetylene cutting torch.

As the work of the torch, when held in the hand of the operator, is comparatively rough, and therefore not satisfactory for a great deal of the work, a machine has been devised which is called the "radiagraph," which holds the torch rigidly and at the correct angle and is provided with an electric motor which, driving through wheels, propels the torch along at a uniform rate of speed which can be adjusted to that giving the best results for the particular type of cut on which it is being used. This machine, illustrated in Fig. 1, has proved one of the most radical developments in the method used in the shipyard so far this century, as it enables plates to be cut with sufficient smoothness and accuracy for the purpose, at speeds shown in the accompanying table, the smoothness of the cut comparing very favorably with that produced with the rougher classes of machine tools.

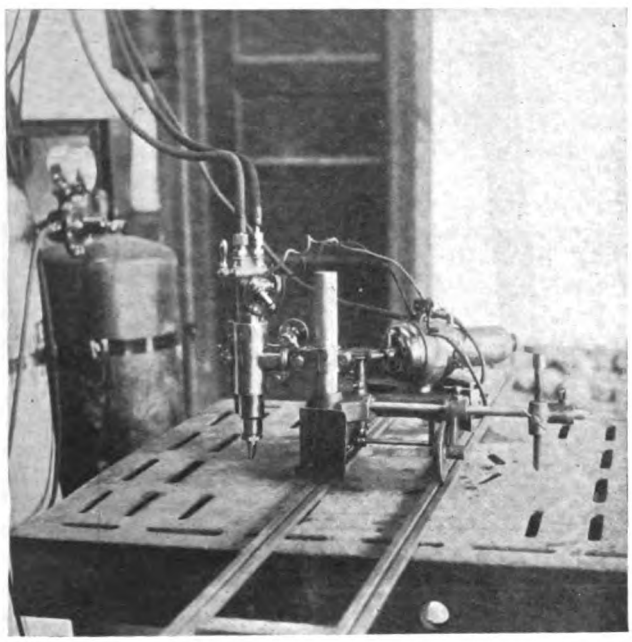

Fig. 1.—The Radiagraph

Approximate Speed of Machine Cutting

Thickness of Steel Inches	Inches Cut Per Minute
¼	18
½	16
¾	15
1	10
1½	9
2	8
3	8
4	6½
5	6
6	5
7	5
8	4
9	4

In addition to work directly connected with the hull, the process is being used very extensively on other parts, including the cutting of steel disks in the construction of turbines. There is, of course, a tremendous field for repair work both for the cutting and welding process, and record times have been made in putting a vessel back into service after a collision, by cutting away the damaged plates in the least possible time. Both the welding and cutting processes are used extensively in the repair of boilers, and this has greatly facilitated the repairs between trips, as the work can be carried out much more expeditiously than by the usual boiler shop methods.

Development of the Twist Drill

THE rapid strides made in marine construction during the past generation are astonishing; and to a large degree they have been made possible by improvements in the design and in the methods of use of the twist drill and other tools which have proven themselves indispensable in the upbuilding of this great industry.

Although in certain branches of marine construction the twist drill appears to be of comparatively minor importance—for instance, in plate work, where a punched and reamed hole is more common than is the drilled hole—nevertheless, in the fitting of the heavy beams and girders and in the building of machinery for the modern steamship the twist drill holds a position of supreme importance. Without it, the perfection of the modern multiple expansion reciprocating engines and steam turbines would be wellnigh unobtainable.

The drills of the early days would hardly be recognized as the forefathers of the present tools. They were made from square bars of steel, the shank forged square and tapering, and the cutting and forged flat on two sides and ground by hand (on a grindstone) sharp and to approximately correct diameter. These drills were called "diamond points." The holes to be drilled were laid out on a chalked surface by compass and prick punch, a large prick punch indentation in the center of each circle being made for the point of the drill to start in. If, as usually happened, the drill started to run to one side of the center the workman, with a round-nosed cape chisel, chipped a little groove down the side of the cone-shaped recess—to bring the drill back where it belonged. As these drills did not *cut*, but *scraped*, the drilling process was very slow.

The accuracy and high uniformity of the modern twist drill is a comparatively recent development. For many years the drill was a comparatively rough tool—turned in a lathe, the flutes milled out and the back clearance filed off or ground by hand. Then the drill was hardened and tempered and shipped just as it came from the tempering process. These early drills were seldom straight, as the metal sprung in the hardening; their surface was apt to be rough and the diameters varied according to the skill of the lathe hand. While they were a great improvement over the flat or diamond-pointed drill, as to cutting qualities, they were still handled in much the same way by the workman, and were such rough tools as practically to obviate the possibility of using them in jigs or holders, and hence in multiple-spindle drilling machines.

Our present use of the twist drill in multiple-spindle drilling machines is a strictly modern development—made possible by the fact that all twist drills are now ground all over to size after tempering and are, as to outside diameter, practically as accurate as reamers. Holes can now be drilled with a high degree of uniformimty and with great speed. As a result, the drilling job in all modern shops has been changed from the slowest and most uncertain to the most accurate and expeditious of all mechanical operations.

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TORPEDO PRACTICE FROM THE DECK OF A DESTROYER

Photographs by the Press Illustrating Service, Inc., New York

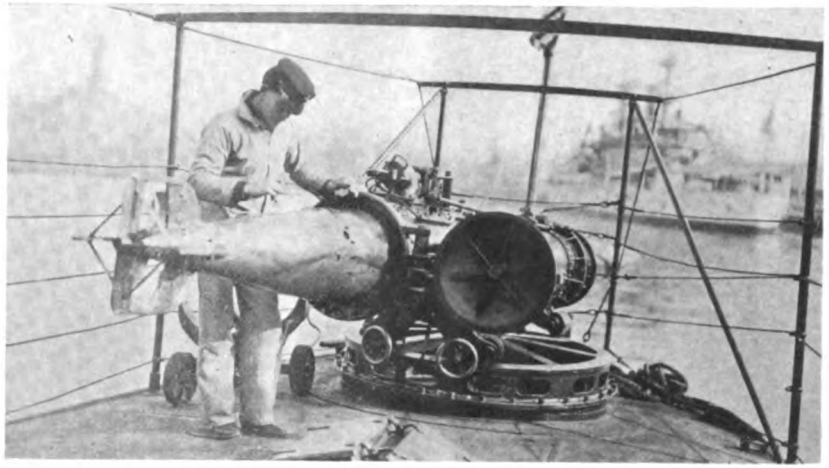

Fig. 1.—Torpedo in the Tube, Ready for Firing

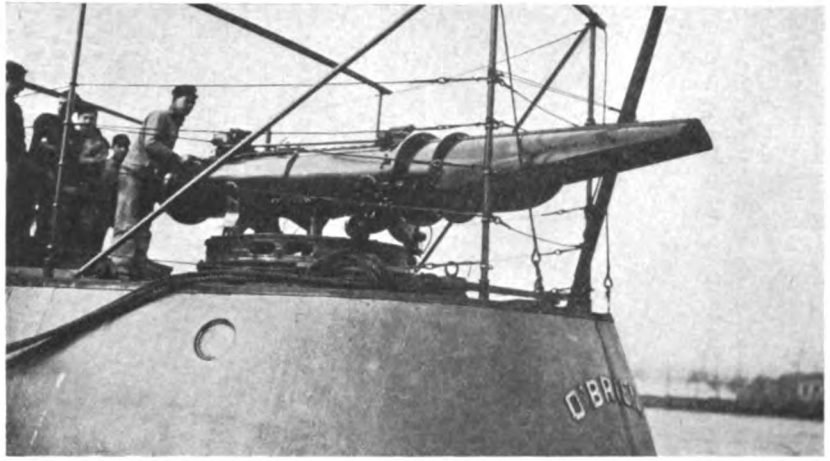

Fig. 2.—Aiming the Torpedo

Fig. 3.—Firing the Torpedo

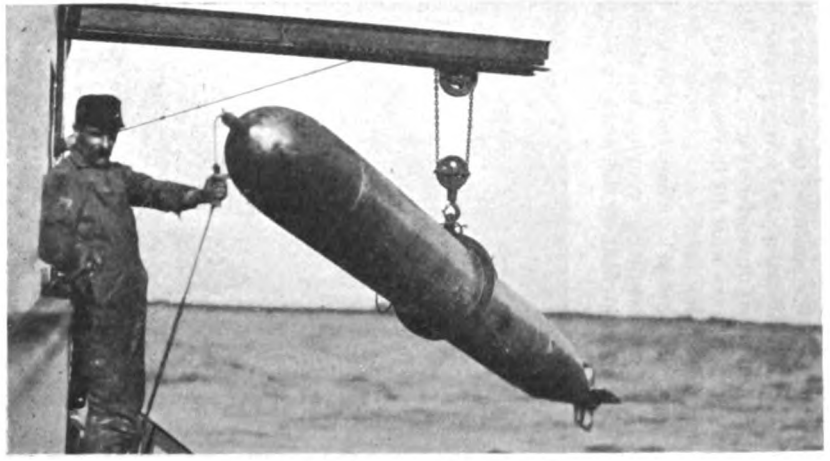

Fig. 4.—Recovery of the Torpedo

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Why Is Ship Classification?

Old Mac Routs the Enemy and Shows the Boys How It is Done

ANOTHER Monday, and with it another wild idea conceived by "Old Man of the Sea"! On Saturday he had borrowed a copy of classification rules and early in the afternoon had stalked away with it and Tek's famous red book under his arm. With all this dope, a full day at home in the bosom of a worshipping family, and with lots of tobacco, something just had to come forth. It did.

On Monday morning, early, he told the Chief, in a severe and convincing way, that the riveting for the shell shown in the plans for his boat was too light; ¾-inch rivets shown must be increased to ⅞ inch, or maybe 1 inch.

The Chief was in the midst of a lot of trouble trying to straighten out some material schedules so that we might use some Belgian stock that was available. When "Old Man of the Sea" sprung his idea, the Chief sized him up with a sad, tired look and asked him please to take the matter up with Mr. Mac, adding that he hoped that such a change would not be necessary because, if it were, many a ship that was apparently all right and well built might suddenly lose her shell and of necessity sink with all on board.

"Old Man of the Sea" said that it was indeed a serious matter. He always had contended that ships were constructed too light, but in this instance he said he was backed up by the classification society.

The Chief knew that "Old Man of the Sea's" company carried their own insurance and this boat was not to be built to the society's rules, but he could see nothing but trouble ahead, and as he had plenty for the rest of the morning, he again patiently asked "Old Man of the Sea" to see Mr. Mac.

This, "Old Man of the Sea" did not want to do, because the fact that the Chief treated the matter lightly made his position less dignified. He was trying to keep clear of "Old Mac" also. He was getting "gun shy," as it were.

Mac saw him talking to the Chief, and when he started in the direction of his table he knew he was in for it. He cut off a large-sized chew and got it softened up by the time "Old Man of the Sea" got started in.

"Yes," admitted Mac, "for that thickness of plate ⅞-inch rivets should be used, but why so thick a plate?"

"The classification society requires it," replied "Old Man of the Sea."

"How do you figure it?" asked Mac.

"Well, you multiply $L \times B \times D$, don't you?"

"No, you don't," said Mac, "you add $B + D$ and multiply by L. No wonder your numeral is large. I don't see how you kept in the table at all."

"Old Man of the Sea" got red in the face. He was so mad that the back of his neck got red. Then he got white in the gills and all his pep left him. After sputtering around for a minute, he turned and stalked out, telling the Chief, as he passed his desk, that he would let the matter stand as it was for the time being. The Chief watched him go out and smiled in a relieved sort of a way.

Tek asked Stevens at noontime, "What was this classification stuff that 'Old Man of the Sea' sprung on Old Mac this morning; some high-brow dope from the Old Country? What was that book he had? I want to get it."

"Mac has the book, but I don't think you can buy it," said Stevens. "Let's ask him.

"Say, Mr. Mac, why is ship classification?"

Old Mac replied: "When it is desired to insure a ship or her cargo by a marine insurance company she must be surveyed and classified and registered in a ship classification society. The classification she gets indicates her desirability as an insurance risk and determines the rate of insurance the shipper will have to pay on the ship and her cargo. To protect themselves from losing money on a poorly-built ship or a ship in poor condition the classification society has employed a staff of capable and experienced men who through a good many years have developed a book of rules for the construction and classification of vessels. If these rules are followed by the shipbuilder, the ship will be satisfactorily classified and registered and insurance at the proper rate can be obtained.

"What concerns us here in the drawing room is properly to interpret these classification rules. This was what 'Old Man of the Sea' was referring to this morning. He made a mistake in applying these rules and tried to work backward and prove that all ships are built too light. He ought to make some rules of his own. All the other companies would get the business. From numerals determined from the dimensions of the ship, the scantlings or sizes of frames, beams, plating, bulkheads, stem and stern frame, frame spacing, riveting, equipment, etc., and, in fact, definite information concerning all the main points can be obtained. This is given for various styles of construction. These rules have become a splendid and recognized authority on shipbuilding generally.

"When a ship is built to classification rules, a midship section and a profile are submitted for approval to the classification society's representative as the builder's interpretation of the rules, or as his idea of some departure from them that may be profitable in his particular case. If approved, and if the workmanship during the construction of the ship is satisfactory to the inspector, then the desired classification can be obtained and a low insurance rate will prevail.

"Almost every large maritime country has one or more ship classification societies. In our country it is the American Bureau of Shipping, in England there is the British Corporation and Lloyds, in France the Bureau Veritas, and so on.

"To get the proper classification with the smallest scantlings is our problem."

Tek wanted to know where he could get one of these books. Mac told him to wait until next month, when the new edition would be out, and then he could have the old one.

LARGE STEEL TUG LAUNCHED FROM BALTIMORE YARD.—The Spedden Shipbuilding Company, Baltimore, Md., launched on March 13 the steel tug *Freeport Sulphur No. 2*, for the Freeport Sulphur Company, of New York. The tug is 160 feet long, 26 feet beam and 14 feet depth of hold. She will be driven by triple-expansion engines with cylinders 21, 32 and 54 inches diameter and 26 inches stroke. The boat is the second largest tug built in a Baltimore shipyard and the third largest in the towing fleet of the United States.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Training Young Engineers

How many of our young engineers come from the ranks of firemen and coal passers, and how many come from the various engineering schools? The writer, not having any statistics at hand, can only speak from observation, and feels that the largest proportion of marine engineers come from the rank and file of the engineer's force of our ships. If this be true, then it speaks volumes in behalf of the men who trained these junior engineers. There undoubtedly must have been a spirit of co-operation between the student engineer and his teachers (the engineer staff). But even with encouragement and desire to become an engineer, the practical school, in the engineer's department of a ship, is a slow, tedious and hard road, and many a lad has had the ambition of attaining that goal knocked out of him by lack of physical strength and courage to buck the fires long enough to win promotion to the next step.

Very few lads have the patience to stick to the fireroom long enough to become thoroughly conversant with boilers, their auxiliaries and proper operation, for they are anxious to get into the engine room. This part naturally appeals to them much more than the firing.

To obtain the balanced training which is required to become an efficient engineer the apprentice to the profession must, of course, receive practical training in the fireroom. The writer has in mind the manner in which some have gained a practical schooling in marine engineering, which, he believes, would in time produce more and better engineers than the hard, slow climb from the coal bunker to the chief's stateroom.

The supervising engineer of a certain line of steamers devised this plan. Four apprentice engineers were allowed each ship of the fleet; the work of instruction of one apprentice was placed in the hands of each engineer; in other words, each engineer had an understudy. It became a part of each engineer's duty to plan the training of his protégé and report his progress to the chief each month. The chief, in turn, reported quarterly to the superintendent who kept the service records of the entire ship's personnel. As each engineer had a separate station of repairs in port, the apprentice after six months with one engineer (say the third assistant) was then given to the second assistant for the next six months and to the first the next six. After this he spent one year in the company's shop or as junior engineer on one of the ships. He was then generally found qualified by examination for a marine engineer.

At sea the apprentice stood a regular watch with his instructor, taking the fires a various period, it always being impressed upon him that study must accompany his practical work. Generally, when a lad completed six months' training on one vessel, he was transferred to another of the fleet. Having some vessels fitted with turbines and oil burners, their training in some instances had to be lengthened; they were permitted to advance as fast as possible, but never until they had satisfied their instructor that they were ready. It is quite natural that some will advance faster than others.

After graduating from this practical school and obtaining his ticket the engineer is under no obligation to the company. He is free to roam at will, but the company has never had to bind any of its engineers; they are anxious to get a berth and stick to their benefactors.

Concord, N. H. C. H. W.

Passing the Buck

The chief received an order from the skipper to inspect the bunkers to ascertain the actual amount of coal on hand and to report when finished the amount required to fill up to total capacity. He told the first assistant to look after this. The first assistant did so by giving the order to the third assistant in charge of the firerooms and coal bunkers. The third assistant gave the order to the chief water tender, who, in turn, gave it to one of the water tenders. This water tender, aided by one of the firemen, inspected the bunkers (each bunker having markings in cubic feet on a predetermined scale). The capacity figures were taken by them and these figures went back through the various hands, until they finally reach the chief, who told the skipper that he wanted 925 tons of coal to fill up the bunkers to their total capacity. This was ordered, and arrived alongside in barges the following morning.

Everything went fine, until near the end of the coaling, when it was discovered that the bunkers were all full except one, which would take about 15 tons more after being trimmed or stowed. But there were still about 100 tons in the barges. Now, the coal barges had been carefully tallied and rechecked in draft, etc., so it was known that there were just 925 tons in them. The tally of coal taken on board showed about 825 tons, so immediately the skipper sent for the chief to find out why the coal was not being stowed faster. The chief told him that there must have been a mistake somewhere—either too much coal had been sent or the wrong estimate made of the coal on hand. He was ordered to find out where the mistake lay.

Then came to light the manner in which the "buck" had been passed, with the result that all hands in their turn got called "on the carpet" before the old man and warned about "passing the buck." The mistake, of course, had been made by the fireman in setting down figures given him by the water tender. The steam log in which the daily coal expenditure had been kept almost tallied with the figures shown by the bunker estimate, for each watch always handed in a little more on the coal slip than they had burned, and as this was the first time that they had filled the bunkers to capacity, it had not been brought to light before.

"Passing the buck" is all right in a poker game, but it should not be allowed to creep into the management of an engineer or other department of the ship. If any of the readers have ever reviewed the proceedings of a court trial, in which the captain, chief engineer, or other ship's officer has been tried for negligence, it will undoubtedly illustrate the meaning of "passing the buck." When a person is tried for negligence in the performance of his

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duty, it is most natural to try to place the responsibility on someone else. This is what is known as "passing the buck." Many times the writer has noted the unfortunate results of this and whenever it lay in his power to correct this he has done so. A rule laid down and very closely followed by him is, that a man to deserve promotion must prove his capacity for retaining the responsibility intrusted to him and not shed it on to his subordinate to escape possible results of certain orders. The story told by the writer about estimating the coal is, of course, not a serious phase of this habit and is related only to illustrate the method. Observer.

Machine Shop Kinks

Fig. 1 shows the odd way in which the slots were machined in a face plate we recently made for one of our lathes. This odd design permits of a more varied lot of

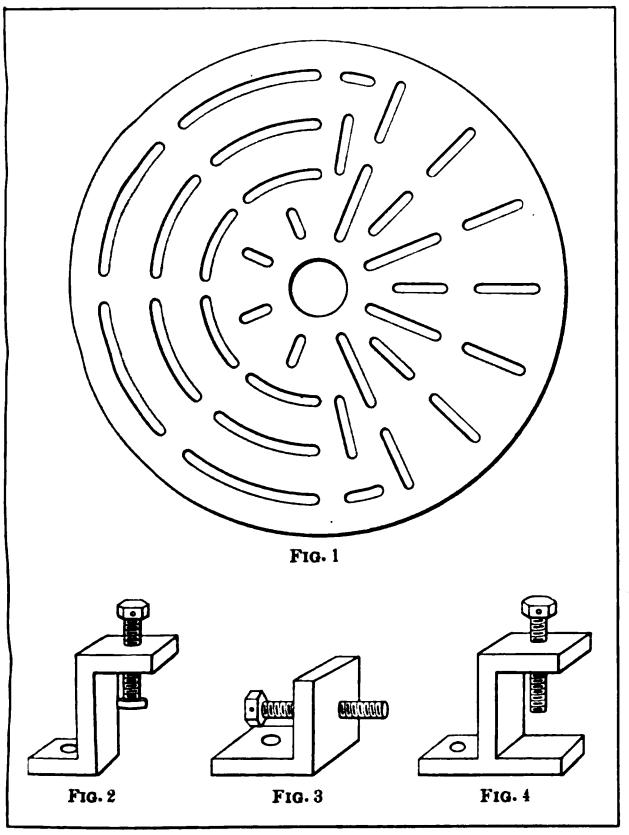

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Unusual Design of Face Plate and Clamps

work to be set up on the plate than was possible on the old radial style slotted plate. The circular slots in one-half the plate have been found exceedingly handy for a large class of work found on board ship.

Handy Clamps

Figs 2, 3 and 4 show some very useful clamps for holding work on the drill press table. Machinist Mate.

New Philadelphia Shipbuilding Plant.—The Fort Mifflin Shipbuilding Company, recently organized with a capital of $10,000,000 (£2,050,000) has purchased 160 acres fronting on the Delaware River immediately below the mouth of the Schuylkill for the erection of a shipyard. The new plant will be within the limits of the city of Philadelphia and the various shops will be combined in a single building 800 feet long by 500 feet wide.

The Bell Tapper, or Shirk

"Messenger! Did you call my relief?"

"Yes, sir. I called him 20 minutes of and he said, 'All right.'"

"Well, you go up and give him another call and tell him that it's past 4 o'clock."

The bell tapper—have you met him? If you haven't you no doubt know of him. The relief, who sticks you sometimes 10 or 20 minutes and comes down on your watch half asleep to relieve you, always with a lame excuse, generally blaming the messenger boy for not calling him—but you notice he never comes down early at any time to make it up, always creeps around at eight bells, even if he has to idle a few minutes away on top side.

The writer has noticed that this type of engineer generally has the rest of the disagreeable traits of the bum relief. Slack and poor watch is generally found at the close of his four hours. Nothing has been properly wiped down, the steam pressure is low and dirty thick fires in the boilers, hardly any relief coal is on the plates, the bilges half pumped, oil manifolds low, feed tanks in need of extra feed and, in fact, endless indications of this shirk are evident.

If the shirk happens to be your junior you can always bawl him out, but if he is your senior you generally have to swallow it. It really is surprising how these fellows do manage to hang on to their job; their salvation seems to hang on to the fact that their relief covers them up by setting things right, rather than complaining justly to the chief.

The true worth of a man is apparent when these things are noted. We have all stood these long, arduous, tiresome rough weather watches, when things went wrong and it was next to impossible to turn over a good relief and we were glad to see it drawing close to eight bells. Who can blame a fellow for feeling hot under the collar when the bell tapper or shirk sticks you? The writer feels that the shirk has no legal place in the engineer corps of a steamer and the sooner he is shown up to the chief the better it will be for the harmony of all concerned. Chief.

Some Notes on Oil Burning

Great care and intelligence are required for efficient results in operating fuel oil burning installations, and as the field of the oil burner is getting broader every day, both on land and sea, a few practical notes from operating engineers would no doubt be of considerable interest not only to those who are associated with fuel oil equipment but to those who like to keep posted on engineering in general.

The handling of the oil in bulk is about as safe as handling coal, but the vapor arising from it, when mixed with air, is highly explosive, and a few precautions must be taken to guard against accidents. The vapor, being heavier than air, will accumulate at low places, such as bottoms of storage tanks or compartments; and should such a mixture be allowed to accumulate, it might remain unknown until ignited by a naked light or a spark, resulting in an explosion.

Leaks of fuel oil, or drips, are therefore to be guarded against and artificial means taken to rid all low levels of any gas vapor. An empty tank or other receptacle used for storage of fuel oil should, before being entered or worked in, have all the vapor expelled by pumping it full of water and then draining it.

Do not permit any smoking, naked lights or any elec-

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trical devices liable to an open spark to be within 60 feet of fuel oil pumps, tanks or piping.

If you have gage glasses fitted to oil tanks, heaters or receptacles, keep the valves closed to the glass except when a reading is desired. Should the glass leak or break with the valves open, great chances of danger are then present.

All fuel oil handling equipment should be kept wiped clean, drip pans dried out, flexible oil hose drained when not in use; or any oil spilled in cleaning the burner strainers should be wiped up. Drip pans are very good things to catch oil around the pumps or burners; they prevent the oil from running into the pits or bilge and over the floor, but the pans must be frequently wiped dry and the oil-soaked waste disposed of.

Proper fire extinguishing equipment should be installed to handle fires, steam hose connected to an always available source of supply and properly insulated for quick and easy handling, chemical fire extinguishers of large pressure tank type, a plentiful supply of fine dry sand in a handy place, with a large shovel for throwing and spreading it, are some of the means used for extinguishing oil fires.

Perhaps more people have been injured from flarebacks in lighting or operating the burners than by vapor explosions and a few words on operating the burners might help to prevent some of these accidents. The first law or rule should be never to attempt to light the oil burner of a boiler until you have made the following examinations:

If your boilers are fitted with dampers, make sure that they are wide open. If you have draft blowers, start one running to create a draft, thus reducing the possibility of a flareback. Examine the furnace to make sure that there are no puddles of oil, and blow through with steam or air. Examine the oil pressure gage to see that it is registering. You should have a pressure of about 200 pounds. Examine the burner, and if you are satisfied that the strainer is clean and the burner tip clear, you are ready to light off. In lighting the burner of a dead boiler, use a torch. Take an iron rod, or piece of pipe 4 feet long, make a waste torch, and secure to the end; soak the torch in oil, light this, and then open the oil to the burner. (The center burner of a group should be the first one lighted.) Open the air regulating valves of the registers wide to allow all air possible for lighting off. Hold the lighted torch close to the burner tip, open the oil supply full, and the burner should light. Bear in mind to stand well back, and use the 4-foot torch.

After lighting the first burner, regulate the draft, and light off the remaining burners, as many as needed, regulating the air-vane openings to control the draft and prevent the panting of the boiler and formation of smoke.

Never light more than one burner at a time, and always the center one first. The wing, or right and left-hand burners of the set should be the last ones to be ignited and the first to be extinguished when shutting down.

If the oil heater is in operation at the time of lighting off, the torch can be held up to the open air vanes instead of the burner tip.

After one burner is in operation the one near it can be lighted without the use of a torch, if the furnace is hot. I have always preferred the use of a torch. *Do not try to light* an oil burner from a *red hot bridge wall*—it has been done, but should you fail to light it there is at once generated dangerous explosive gases that will flare back. Never take any fool chances in handling the oil burner—it might cost you your life, and you might kill someone else.

If, when you are trying to light off a burner, your torch goes out, shut off the oil immediately and do not attempt to relight the burner until you are sure that the furnace is clear of gases by blowing through it with air or steam. If you do not do this, your burner will drip oil on the furnace floor and some of the oil spray will mix with the air, forming highly explosive gas, and any attempt to relight the burner will ignite this and explode it. The same applies to relighting a burner which has been burning and become extinguished.

Burners sometimes go out, due to the tip becoming plugged with some foreign substance, or the oil becomes broken down and carbonized, due to overheating in the oil heater; it should never be heated to more than 110 degrees F. Sometimes water gets in the oil supply; this causes the burners to become extinguished. No matter what causes a burner to go out, always find the cause and use the precautions described before trying to relight it.

Clean out your oil strainers often, once every eight hours is sometimes required; of course, a great deal depends on the quality of the oil. Much of the success of oil burning depends on the oil pumps; they must deliver a constant steady pressure to the burners. Air chambers fitted to the discharge side of them are valuable; in fact, absolutely necessary for properly burning the oil. These air chambers should be kept charged up with plenty of air pressure, about 80 or 90 pounds gage pressure. Fuel oil absorbs the oxygen of the air quite rapidly, therefore considerable attention should be given to these air chambers. It is usually the practice to also install them on the dead ends of the burner supply lines; they aid in removing the pulsation of the pump when properly charged up with air.

Pack the plungers of your oil supply pumps with a white metal, or lignum vitæ packing. Metal disk valves are the best for oil pumps, and last longest. The valves and cylinders of the oil end should be examined and cleaned often and regular. C. H. W.

Education of the Marine Engineer

Recently a committee was appointed by the council of the Liverpool Engineering Society to inquire into the education of the marine engineer, with a view to improving his general educational status and efficiency, and so enabling the keen competition in the future to be coped with by this important branch of the mercantile marine, and to formulate recommendations which will fulfil this object.

The committee's investigation of the subject was carried out along lines suggested by the following questions:

(1) Are the present qualifications for first and second class certificated marine engineers, as at present laid down by the Board of Trade, satisfactory?

(2) In what ways, if any, are these certified engineers, taking the class as a whole, considered to be deficient?

(3) Does the system of examination at present adopted by the Board satisfactorily ensure that the engineer may be said to have the knowledge described in the printed qualifications

(a) as to actual manual practical training;

(b) as to knowledge of principles of action and details of construction of marine engines—main and auxiliary?

(4) What are the supposed reasons for the deficiencies of the system?

(5) What remedies can be suggested and recommended for establishing a satisfactory training during school and apprenticeship stages?

(6) What course should be taken and what are the

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proper bodies to approach to endeavor to bring these recommendations into effect?

The committee, after careful deliberation, unanimously came to the conclusion that the present regulations were not entirely satisfactory. They were not such as to insure that a certified man was capable of intelligently controlling and overcoming many of the difficulties presented by the main or auxiliary machinery and the boilers of modern steamers. This opinion is not held of the engineer holding an extra first class certificate, but refers to the ordinary second and first class certificated engineer. As the majority of first and extra first class certificates are obtained subsequent to a second class certificate, it was only logical to consider, first, the qualifications for the second class certificate. It was very quickly established that at this stage in the test of the engineer's qualifications there was most need of reform. The committee are agreed that the fundamental weakness of the marine engineer as a class lies in his lack of general knowledge of English, mathematics, physics and applied mechanics, and consequently a notable lack of general intelligent reasoning power, which has now become essential for the satisfactory control of the increasingly complicated machinery utilized in ships of the mercantile marine.

Evidence has been adduced of the inability of certificated engineers to make simple reports or returns, simple entries for the log, to read a revolution counter, and carry out other simple but important operations which could readily be done with even a small power of reasoning.

The committee consider that the examination papers set by the Board of Trade do not satisfactorily fulfil that object, for although the syllabus of subjects is on the whole satisfactory, the type of question appears to have become so stereotyped that it is possible for a candidate who attends a "cramming school" specially devoted to the cramming of engineers to obtain Board of Trade certificates to answer these questions outwardly in an intelligent manner, but actually without real knowledge of the subject. The committee do not underestimate the difficulty the Board of Trade has to meet in holding examinations for the same subject and purpose so frequently without more or less repetition of questions, but are of the opinion that the general qualifying regulations can and should be so framed that only the candidate with a competent knowledge, coupled with good reasoning power, shall be able to obtain his certificate, with the result that the "crammed production" will be eliminated.

The reasons for the alleged deficiency of the system lie, it is unanimously considered, in the defective early training of the candidate and the lack of opportunity and incentive.

The committee, therefore, devoted themselves to drawing up a scheme which would tend to remedy the palpable needs of the mercantile marine engineer. The recommendations which are made will no doubt appear very radical, but the committee are convinced that they will, if adopted, render the service more efficient, a result which will be of actual benefit to the officer, the shipping industry and the community. These are embodied in the *following, setting out* the qualifications for second class *certificates:*

Qualifying Certificates for Second Class Engineers of Steamers of Not Less Than 100 Nominal Horsepower, as Defined in the Board of Trade Regulations.

A candidate for a second class engineer's certificate must

(a) be not less than twenty-two and one-half years of age,

(b) have served as an apprentice engineer for five years at least, or, as an equivalent, three years as an apprentice engineer and three years at approved technical school or college,

(c) produce testimonials to the satisfaction of the Board of Trade,

(d) in addition to the apprenticeship as described below, have served eighteen months at sea as engineer on regular watch on the main engines or boilers of a foreign-going steamer of not less than sixty-six nominal horsepower, or twenty-seven months in a home-trade steamer of not less than sixty-six nominal horsepower.

It must be shown that during the five years' apprenticeship under requirement (b) the candidate has been employed in the manner set forth below:

(1) No service as apprentice prior to the age of sixteen will be recognized as part of the specified minimum period of apprentiseship.

(2) Workshop service in works where engines and boilers are made and repaired. Not less than two years of the apprenticeship must have been spent at fitting, erecting, or repairing engines and machinery either in the works or outside. The remaining three years may have been made up of time spent (1) in engine works at fitting, erecting, or repairing engines and machinery, or (2) at one or the other trades described below, or (3) at an approved technical day school or college, and, in this case, in the workshops for an additional period of one year.

The time spent in the workshops shall be counted as follows:

Fitting, erecting, repairing, or turning-full time.

Working in drawing office, full time up to one year; beyond one year, half time.

Pattern making, full time up to six months.

The main principles underlying the recommendation are, first, the creation of a new class of engineer who is not a bona fide mechanic, having served no apprenticeship and is simply a handy man who has made himself efficient to a certain extent by experience derived from his familiarity with a certain type of machinery, and who will not be granted a certificate, but a license to serve as engineer or watch-keeper in certain low-powered vessels; second, the essential establishment of a requirement to be met in obtaining a second class certificate, making attendance at schools of approved character during the period of apprenticeship compulsory. The result of the committee's recommendations, therefore, will be to draw a distinct line of demarcation between the certificated engineer and the licensee, and, moreover, generally speaking, to discountenance, in respect to the second class certificated engineer, sea service as an equivalent to general knowledge of the principles of marine engineering without in any way sacrificing the qualifications necessary to enable the certificated engineer to carry out personally or supervise emergency repairs at sea.

The investigation and recommendations by the committee of the Liverpool Engineering Society emphasize the great need of help from our Federal Government for the education of marine engineers in the United States. Uncle Sam should assist our marine schools at New York, Buffalo, Cleveland, Milwaukee, and other cities. Help could be given these schools by the appointment of an instructor detailed from the Navy, Coast Guard or other service.

The need for machine shop practice is also urgent. Even one month of such experience would be a great help, and our schools for the instruction of applicants for a marine engineer's license should make arrangements with machine shops, so that the applicant can at least have some drill with machine tools. Marine Engineer.

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NEW BOOKS FOR MARINE ENGINEERS

PRACTICAL MARINE ENGINEERING. Fourth edition. Revised and enlarged. By Capt. C. W. Dyson, U. S. N. Size, 6 x 9 inches. Pages, 982. Illustrations, 550. New York, 1917: MARINE ENGINEERING. Price, $6.

The first edition of this book, published in 1901, was written by Professor W. F. Durand, at that time head of the department of naval architecture and marine engineering at Cornell University. Since that date the book has run through three editions, with some minor changes and additions to cover new developments in marine engineering. The new edition, however, has been thoroughly revised and entirely rewritten by Captain C. W. Dyson, of the Bureau of Steam Engineering, United States Navy Department, one of the foremost authorities in steam engineering and marine propulsion in the United States to-day.

In the new edition those parts of the original book dealing with the fundamental principles of marine machinery have been retained, but the order of treatment has been changed, so that the various parts of the book have been brought together to form one connected book of fifteen chapters. Much new material has been added in order to bring the book thoroughly up to date, although the recent advance in marine engineering has been so rapid that it has been necessary to make the descriptions of new machinery and appliances as short as possible. The new matter deals principally with such subjects as steam turbines, improved watertube boilers, fuel oil burning, superheated steam, oil engines and a great number of auxiliaries which have recently been perfected and are generally adopted in modern marine practice.

The original purpose of this book, to provide help for the operative or practical marine engineer, either for the man who has already entered the profession, who may wish to perfect himself more fully in many branches of the subject, or for the applicant for the lowest round of the ladder or for the young man whose attention is first turning to this field, and who may wish some simple and fairly complete presentation of the subject from a practical standpoint, has not been deviated from. The treatment of the subject throughout has been with a view to simplicity, and only such parts of the general field of engineering have been included as are of special interest to the practical marine engineer. No attempt is made to treat of the designing of marine machinery except in an incidental way, but the topics of construction, operation, management and care, which are of paramount importance to the practical engineer, have been covered thoroughly.

Materials of engineering construction and fuels are first taken up; then the latest types of marine boilers are described, together with superheaters and accessories. In this connection the latest rules of the United States Board of Supervising Inspectors of Steam Vessels for the construction of steam boilers have been given in full. The chapter on oil fuel burning is practically new and not only describes the latest types of fuel oil burners, but also the methods of operating an oil-fired boiler.

While the marine engineer sixteen years ago was concerned only with the reciprocating steam engine, to-day he must be familiar also with the construction and operation of steam turbines, internal combusion engines, both of the explosive and of the Diesel types, and their various accessories. All these classes of propelling machinery are described in detail, together with the special auxiliaries required for each type, as well as many new auxiliaries which have recently been perfected.

In the chapter on operation, management and repair, which is of special interest to the practical marine engineer, much new valuable information is given regarding the operation of turbine-propelled vessels. The subject of steam engine indicators has been amplified by a section on torsion meters for determining the horsepower of turbines.

The book contains a collection of miscellaneous problems and discussions, many of which will be of value to the professional engineer in connection with the various questions likely to arise in his experience. At the end of each chapter are questions, with a page reference to the part of the book where the answer to each question may be found. It is believed that the subject matter thus presented will be extremely useful to an applicant for a marine engineer's license, as the subject matter on which such examinations are based is thoroughly covered in language which can easily be understood.

DESIGN OF MARINE ENGINES AND AUXILIARIES. By Edward M. Bragg, S. B. Size, 6 x 9 inches. Pages, 183. Illustrations, 110. New York, 1916: D. Van Nostrand Company. Price, $3 net.

This book is an enlargement of a previous work by the same author which originally appeared as a serial in MARINE ENGINEERING. The book is divided into five sections dealing with the determination of cylinder dimensions, design of engine parts, engine balancing, condensers and air pumps and turning engines and reversing engines. The only parts of the book for which the author claims originality are the method of design, method of obtaining mean bearing loads, the use of the mean lead in the solution of valve diagrams, the method of designing condensers and the method of designing turning engines. The methods described are thoroughly workable; in fact, the whole treatise is one which can be readily accepted as a convenient and accurate guide for the calculations which it covers. Designers of marine machinery will find the work of great value as well as students or draftsmen who are taking up engine work in shipyards.

JOHNSON'S STEAM VESSELS OF THE ATLANTIC COAST, 1917. By Eads Johnson. Size, 8 x 4¼ inches. Pages, 240. New York, 1917: Eads Johnson Publishing Company. Price, $5.00.

This book is an annual publication containing a complete and accurate list of the mercantile steam vessels of American Registry on the Atlantic seaboard, together with the main particulars of each vessel arranged in such form as to be convenient and instantaneously available for reference. First is given an alphabetical list of the steamship companies and owners of vessels; then an alphabetical list of each vessel with the owners' name, supplemented by an alphabetical list of former names of vessels listed in the book and, finally, the particulars of all of the vessels of the various fleets arranged alphabetically according to the name of the owner.

SUBMARINES: THEIR MECHANISM AND OPERATION. By F. A. Talbot. Size, 5 x 7¼ inches. Pages, 274. Numerous illustrations. Philadelphia, 1915: J. B. Lippincott Company. Price, $1.25 net.

This book was written essentially for the general reader who desires to acquire a rudimentary knowledge of the construction and operation of submarines. It describes particularly the Lake and Holland types of submarines, together with the machinery used for both surface and submerged propulsion. Interesting chapters deal with the testing and salvage of submarines. The book is clearly written, splendidly illustrated, and apparently based upon an accurate knowledge of the subject.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Size and Pitch of Rivets in Boiler

Q. (869).—What size rivets should be used for a boiler plate 26/100 inch thick and how far apart should they be spaced?

A (869).—First find the minimum diameter of rivet, by equating the resistances for shearing rivets to tearing of plate (single riveted butt joint assumed).

$$(p - d)\ tf_t = (p - 2d)\ tf_t + \frac{\pi d^2}{4} f_s,$$

$$d = \frac{4tf_t}{\pi f_s} = \frac{4 \times 0.26 \times 55{,}000}{\pi \times 45{,}000} = 0.405 \text{ inch.}$$

Use 5/8-inch rivet diameter as minimum. Then from Table X, p. 160,† the maximum allowable pitch is 1.72 inches.

Answer: Pitch maximum allowable, 1.72 inches. Diameter is 5/8 inch.

p = pitch of rivet in inches,
d = diameter of rivet in inches,
t = thickness of shell plate in inches,
f_t = 55,000 pounds per square inch,
f_s = 45,000 pounds per square inch.

Strakes of Shell Plating

Q. (864).—To settle a dispute, will you please name the strakes on ships of old and new construction? Also give method of getting constant for working out horsepower, and give example?

A (864).—The question is vague, in that it does not specify what part of the ship is under discussion, whether shell, deck, inner bottom, etc., but assuming that it refers to the shell plating of a steel ship, there has been no change in the naming of those strakes which commonly receive specific names, such as keel, garboards, bilge, and sheer strake.

Horsepower is computed from the following expression:

$$I.H.P. = \frac{2PLAN}{33{,}000}$$

where P = mean effective pressure from indicator diagram in pounds per square inch,
L = length of stroke in feet,
A = area of piston in square inches,
N = number of revolutions per minute.

For a given cylinder A and L are the same so $\frac{2LA}{33{,}000}$ can be computed once for all, called the engine constant, and simply multiplied by the mean effective pressure and revolutions per minute to get the horsepower for those runs. In accurate work allowance should be made for the area of the piston rod, or tail rod, as the A in the formula is always net area. A single cylinder engine of 18-inch diameter by 24-inch stroke, with piston rod of 2 inches, has the following returned trial data:

Run No.	1	2	3	4	5
M. E. P. (average of both ends).	10	35	60	80	90
R. P. M. (average of both ends).	50	65	78	90	100

the area of the head end is

$$A_h = \frac{\pi \times 18^2}{4} = 254.5 \text{ square inches;}$$

subtracting the area of the piston rod, the piston area for crank end, is 254.5 — 3.1 = 251.4 square inches. The average of both ends is 505.9, divided by 2 = 252.95, use 253.0, the engine constant is then

$$\frac{2 \times \frac{24}{12} \times 253}{33{,}000} = .03067;$$

the horsepower, then, for the various runs will be:

$$C \times P \times N = I.H.P.$$

Run 1.....	.0367 x 10 x 50 =	18
2.....	.0367 x 35 x 65 =	83
3.....	.0367 x 60 x 78 =	172
4.....	.0367 x 80 x 90 =	264
5.....	.0367 x 90 x 100 =	330

Wake Gain and Thrust Deduction

Q.—Will you please explain what is meant by "wake gain" and "thrust deduction"? N. S.

A.—If a vessel without propeller were propelled at a speed V_s by an external force applied at the thrust block, the push would be just equal to the resistance (R) which the vessel would offer to being towed. The useful or effective horsepower is then E. H. P. = $R \times V_s \times .00307$.

If a vessel, with a propeller operating at its normal R. P. M. behind it, is propelled by an external force applied at the thrust bearing at such a rate that the propeller exerts no thrust, the force required (T) will be equal to that which the propeller is delivering, but larger than the resistance (R) by the suction of the column of water drawn from the hull to the propeller. This added resistance is expressed as a percentage (t) of the total thrust (T), so that the thrust at the thrust block is

$$T = R + t\,T = \frac{R}{1 - t}$$

The horsepower to drive the ship is this thrust multiplied by the distance it moves through and by a constant, so that the thrust horsepower or horsepower applied at the thrust block is

$$T.H.P. = T \times V \times .00307 = \frac{.00307\,V_s \times R}{1 - t};$$

but

$$.00307\,V\,R = E.H.P.,$$

so

$$T.H.P. = \frac{E.H.P.}{1 - t}$$

Obviously, if there is no propeller acting there is no thrust deduction, and then $T.H.P. = E.H.P.$

A propeller operating in still or flowing water receives

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

† "Design of Steam Boilers," Haven & Swett.

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the power, *S. H. P.* (sometimes expressed as gross horsepower, *G. H. P.*) and delivers the useful power of *S. H. P.* × Eff. of Propeller.

This useful horsepower is a function of the thrust of the propeller times the distance through which it acts in a unit of time. This latter is the speed of advance (V_a) of the propeller through the water surrounding it, so that we may write,

$$S.H.P \times Eff_p = \text{thrust} \times .00307\ V_a$$

and the propeller thrust is then

$$T = \frac{S.H.P. \times Eff_p}{.00307\ V_a}$$

The thrust that the propeller gives must be equal to the thrust required at the thrust block to propel the ship with a propeller operating in place. This has been deduced as

$$T = \frac{R}{1-t}$$

therefore

$$\frac{S.H.P. \times Eff_p}{.00307\ V_a} = \frac{R}{1-t}$$

When the propeller is working in place behind the ship, it is in the wake, which has a speed forward of w expressed as a percentage of the speed of the ship, so that the speed of the propeller through the water surrounding it is,

$$V_a = V_{ship} - V_{wake} = V_a - wV_a = V_a\ (1-w),$$

$$\text{then } S.H.P. = \frac{.00307\ R\ V_a\ (1-w)}{Eff_p\ (1-t)}$$

$$= \frac{E.H.P.}{Eff_p} \times \left(\frac{1-w}{1-t}\right)$$

$$E.H.P. = S.H.P. \times Eff_p \times \left(\frac{1-t}{1-w}\right)$$

$\frac{1-t}{1-w}$ is termed the hull efficiency (E_h)

and

$$E.H.P. = I.H.P. \times Eff_{eng.} \times Eff_{prop.} \times Eff_{hull.}$$

Power Delivered by Chain of Gears

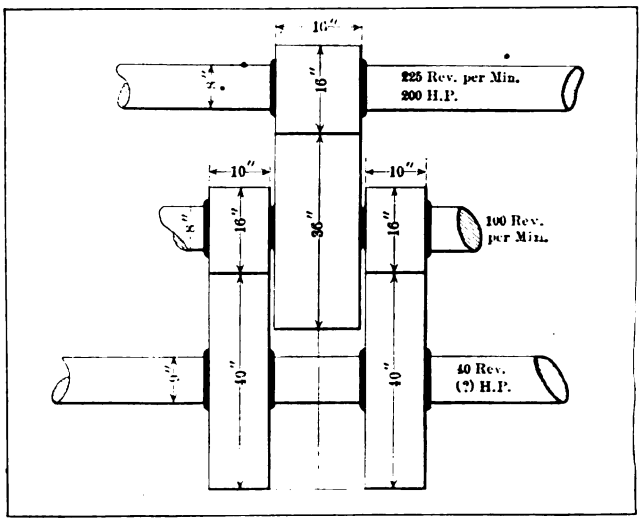
Q. (863).—The accompanying sketch represents a chain of gears. What horsepower is developed by the 9-inch shaft? Also, what is your opinion as to the sizes of the several gears as shown in the sketch? The top 8-inch shaft is a fixed quantity, as is also the 225 revolutions. The desired number of revolutions for the bottom, or 9-inch shaft, is anywhere from 40 to 50.

A (863).—If we neglect frictional losses the horsepower delivered by the 9-inch shaft is exactly the same as that put in by the 8-inch shaft. "Power" is the *work done per unit of time,* and "work is the force acting multiplied by the distance through which it acts. In dragging a weight over the ground by a horizontal pull of 100 pounds, when it had moved 10 feet there would have been 10 × 100 = 1,000 foot pounds of *work* performed. Now, if this has to be done in one second the *power* necessary would be 1,000 foot pounds *per second,* or (as 550 foot pounds per second are called, 1 horsepower),

$$\frac{1{,}000}{550} = 1.82 \text{ horsepower.}$$

If, however, the work was done in one-tenth of a second instead of a second, while the *work* would be the same, the work per unit of time or power would be 1,000 × 10 = 10,000 foot pounds per second, or 18.2 horsepower.

In your problem the work done is exactly the same on the driving and driven shaft (neglecting friction), for it is impossible to create energy. The only difference is in the component parts, those of the driving shaft being a small torque (or force), which moves through a large distance (revolutions per minute), and those of the driven end, a large torque moving through a small distance. The revolutions are correct for the pitch diameter given and, neglecting friction, the horsepower output will be 200 at 40 revolutions per minute. Well-cut gears have small frictional losses, but considering friction the output should be about 95 to 98 percent of the input, or from 190 to 196 horsepower at 40 revolutions per minute. The size of driven shaft, however, needs correction. If we accept the driving shaft as correct for the power and revolutions



Sketch of Train of Gears

per minute given, then the driven shaft should bear the following relation to it:

$$\frac{(\text{Diameter of driving shaft})^3}{(\text{Diameter of driven shaft})^3} = \frac{\text{R. P. M. driven shaft}}{\text{R. P. M. driving shaft}}$$

This would give for the proper size of driven shaft

$$\frac{8^3}{D^3} = \frac{40}{225}$$

$$D^3 = \frac{512 \times 225}{40} = 2{,}880$$

$$D = 14.2 \text{ inches}$$

instead of the 9 inches quoted. The above is for solid shafts; if the shaft are hollow the relation is

$$\frac{D^4 - d^4}{D},$$

where D and d represent the outside and inside diameters, respectively.

Number of Stays for Boiler Head

Q. (870).—Diameter of boiler, 42 inches; steam pressure allowed, 175 pounds per square inch; height above line for flues, 15 inches. Give area in square inches and the number of stays required to support head?

A (870).—There are insufficient data for the solution of this question; a sketch giving principal dimensions should be submitted.

CANADIAN SHIPBUILDING BOOM.—With the expenditure of $100,000,000 (£20,500,000) for new merchant vessels, the appropriation of $17,000,000 (£3,500,000) more for coast patrol and other boats and the offer of big subsidies for the opening of new shipbuilding plants, Canadian shipbuilding interests are preparing for extensive developments. It is understood that large new shipbuilding plants will be established on both the Atlantic and Pacific coasts, while a large share of the new business will fall to shipbuilders on the Great Lakes. Negotiations are also in progress with a view to introducing the manufacture of steel plates and structural steel for ships in Canadian plants.

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Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

In view of the extensive contracts now being awarded for naval construction large orders for shipyard equipment are being placed. The Newport News Shipbuilding & Dry Dock Company is expending $2,500,000 for improvements. The New York Shipbuilding Corporation, the Globe Shipbuilding Company and other shipbuilding companies are buying heavily.

On March 15 the Secretary of the Navy awarded contracts for four battle cruisers and six scout cruisers at an estimated cost for hulls and machinery of $111,500,000. Contracts for the battle cruisers were made on a basis of cost plus 10 percent, two to the Newport News Shipbuilding & Dry Dock Company and one each to the Fore River Shipbuilding Corporation and the New York Shipbuilding Corporation. Contracts for the scout cruisers were given, two each to the Seattle Shipbuilding & Dry Dock Company, the Union Iron Works and the William Cramp & Sons Ship & Engine Building Company.

Bids will be opened by the Navy Department on April 4 for fifteen destroyers, on April 11 for thirty-eight submarines, and at an early date for three battleships. Sixty 110-foot submarine chasers have been ordered from the New York Navy Yard, and bids from private shipbuilders for 200 others are now being considered.

The Secretary of the Navy is authorized by Congress to pay 20 percent bonuses for early delivery of naval contracts, and an emergency fund of $115,000,000 is available for speeding up naval construction. The 8-hour law on government work has also been suspended.

To determine the overhead charges to be paid by the Government for the construction of the five battle cruisers contracted for on the basis of cost plus 10 percent, the Secretary of the Navy has appointed the following special naval board: Naval Constructors David W. Taylor and Washington L. Capps, Civil Engineer Harry H. Rosseau, Engineer-in-Chief Robert S. Griffin and Pay Inspector David Potter.

Vice-Chairman Brent, of the Federal Shipping Board, is investigating wooden shipbuilding conditions on the Pacific Coast, where some 115,000 tons of wooden vessels are now under construction. The Board wishes to learn the possibilities of the rapid construction of a large fleet of moderate-sized wooden vessels to meet the urgent needs of over-seas commerce.

Cunard Line and Royal Mail Steam Packet Company Give Large Contracts for New Vessels to American Shipbuilders

The Cunard Line, New York office, 21-24 State street, has placed orders in this country for twenty or more freighters varying in size from 7,500 to 15,000 tons. It is impossible to secure correct information, but, so far as it can be approximated, the Bethlehem Steel Corporation, 111 Broadway, New York, will build at least six ships, to be divided up among its constituent companies—the Fore River Shipbuilding Corporation, Quincy, Mass., Maryland Steel Plant, Sparrows Point, Md., and the Union Iron Works, San Francisco, Cal.

According to reports, the Duthie Shipbuilding Company, Seattle, Wash., has contracts for "more than one vessel," and the same applies to the Ames Shipbuilding & Dry Dock Company, Seattle, Wash.

The Todds Shipyards Corporation, 15 Whitehall street, New York, is reported to have contracts for six vessels, to be built in yards of constituent companies—the Seattle Construction & Dry Dock Company, Seattle, Wash., and the Todd Shipyards Corporation, Tacoma, Wash.

The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., and Moore & Scott, San Francisco, Cal., are each reported to have contracts for two vessels, and the Northwest Steel Company, Portland, Ore., for one or more.

In addition to orders for vessels to be built, the Cunard Line is reported to have purchased contracts for several vessels under construction.

Another large British steamship company, the Royal Mail Steam Packet Company, 26 Broadway, New York, Sanderson & Son, local agents, is understood to have just about completed negotiations for the construction of a dozen or more large steamships in American shipyards.

Shipbuilding Contracts

Information regarding the fleet of towboats, each vessel to be about 125 feet long and to have 500 horsepower, mentioned in our March issue, can be had by addressing the Halcolm Ellis Engineering Corporation, 1482 Broadway, New York. We understand this company has the placing of the contracts for these vessels.

It is reported that the New York Shipbuilding Company, Camden, N. J., which is enlarging its plant in preparation for the construction of the battleships *Colorado* and *Washington*, will start work on four standard freight ships on its own account. According to report, two of the vessels are to be of 5,550 tons deadweight and two of 4,000 tons deadweight.

The American Shipbuilding Corporation, Spokane, Wash., has contracts to build eight lumber ships at a total cost of $2,400,000. Each vessel will be 300 feet long, and will be equipped with two Diesel engines.

Work is reported to have been begun in the new shipyard of Supple, Ballin & Lockwood, Portland, Ore., on two 4,000-ton wooden ships for the Gaston, Williams & Wigmore Steamship Corporation, New York.

The Vancouver Shipyards, Ltd., Vancouver, B. C., are building two 76-foot gasoline-engined fishing boats for the Columbia River Packers, Portland, Ore.

The Mark Johnson Yards, Leschi Park, Lake Washington, Seattle, have secured a contract for a 65-foot cruiser for N. W. Starrett. Lee & Brinton, naval architects, 22 Colman Dock, Seattle, Wash., designed the vessel.

The Ballard Marine Railway, Ballard, Wash., will build a large cannery tender and several scows for Alaskan parties.

Kruse & Banks Shipyard, North Bend, Ore., is building a lumber schooner for Oliver J. Olsen.

The McLean Contracting Company, Baltimore, Md., will build six sea-going barges for the Northern Transportation Company.

The Townsend Marine Railway & Construction Company, Boothbay, Me., has received a contract from Crowell & Thurlow Company, Boston, Mass., to build two more 200-foot, four-masted schooners.

The Sloan Shipyards Corporation, Seattle, Wash., will build four 280-foot wooden motor ships for the Clinchfield Navigation Company, 29 Broadway, New York.

The Elliott Bay Yacht & Engine Company, Seattle, Wash., has received an order from the United States Bureau of Fisheries, Washington, D. C., to build two patrol boats. Martin C. Erismann, naval architect, Seattle, Wash., designed the boats.

The Navy Department, Washington, D. C., has advertised for bids for 15 destroyers. Proposals for 38 additional 800-ton submarines will be advertised immediately.

The Navy Department will shortly advertise for bids for three 42,000-ton dreadnoughts.

The Union Iron Works Company, San Francisco, Cal., has received a contract from the Rolph Navigation & Coal Company, San Francisco, for two 135-foot ocean-going steel tugs.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the United Fruit Company, Boston, Mass., to build four steamships. It is stated that these ships will be larger and faster than any now owned by the United Fruit Company.

W. I. Babcock, naval architect, 17 State street, New York, has designed two twin-screw steel, six-masted auxiliary schooners, each 350 feet long, for the Aluminum Company of America, 120 Broadway, New York, to be built at the yard of the Riter-Conley Company, Baltimore, Md.

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W. I. Babcock has also designed four wooden twin-screw motor ships for the Clinchfield Navigation Company, 29 Broadway, New York, to be built by the Seattle Construction & Dry Dock Company. These vessels will each be 280 feet long, and will have a capacity for about 3,200 tons of coal.

The National Shipbuilding Company, organized by Capt. O. D. Trieber, Seattle, Wash., has received a contract to build a cannery tender for the Nooksack Packing Company, Portland, Ore.

The Standifer-Clarkson Shipbuilding Company, Portland, Ore., has a contract to build another wooden vessel for the Inter-Ocean Trading Company, San Francisco.

The Coastwise Shipbuilding Company, Baltimore, Md., has received a contract from the Cook-Cummer Steamship Company, Philadelphia, Pa., to build a 200-foot sea-going barge.

The Seattle Construction & Dry Dock Company, Seattle, Wash., will overhaul and repair the steamship *Admiral Wainwright* at a cost of about $40,000.

The Sun Shipbuilding Company, Chester, Pa., has received a contract from the Cunard Line for two 10,000-ton standard cargo vessels, at a cost of about $1,250,000 each. The ships will be 435 feet long, drawing 25.9 feet; they will be equipped with 2,800-horsepower reciprocating engines, developing a speed of about 10½ knots. The company now has orders for ten vessels of this type, and is employing a force of over 1,000 skilled mechanics.

The Seattle Construction & Dry Dock Company has closed a contract with the Cunard Line to build six 7,500-ton steel freighters for delivery in 1918. These ships are to be 396 feet long over all, 53 feet beam, with a molded depth of 29 feet 3 inches. They will each be powered with a 2,500-horsepower engine, driving a single screw, and steam will be supplied from three Scotch marine boilers. It is understood that the contract price is something over $6,000,000. The first ship is to be delivered in April, 1918, and the last one in September.

The Skinner & Eddy Corporation signed on March 3 a contract to build a 9,500-ton oil tanker for Eastern interests. Work will be started on this contract some time in the summer for delivery next year.

Libby, McNeil & Libby have let a contract to Standifer & Clarkson, of Portland, for a twin-screw motorship. The new vessel will be 240 feet long over all, 44 feet beam and 23 feet depth of hold. The ship was ordered for delivery for the 1918 season. She will be twin-decked, with three cargo hatches fitted with electric winches. The type of engines has not been decided. She was designed by Capt. C. J. Carlson, port captain for the Libby, McNeil & Libby Company.

Shipyard Notes

The International Shipbuilding Corporation, Ltd., capitalization $2,000,000, has just been incorporated in Montreal, Quebec. This company is reported to be backed by either the British government or British shipping interests for the purpose of establishing a large shipyard in Canada to build ships for British owners.

The Western Shipbuilding Corporation, Seattle, Wash., has taken over the partially completed plant of the People's Shipbuilding & Construction Company, Tacoma, Wash. It is understood that the company has already secured contracts to build several ships. A. B. Gellerman is president of the Western Shipbuilding Corporation, and has opened offices in the Burke building, Seattle.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has authorized improvements to its plant to cost about $850,000. The purchase of machinery and other equipment is in charge of H. P. Phelps, plant engineer, Newport News.

It is reported that the Rolph Navigation & Coal Company, San Francisco, Cal., has purchased the plant of the Bendixen Shipbuilding Company, Eureka, Cal., and will build wooden coal barges and sailing vessels.

R. T. Stone and others, operating under the name of the Terminal Co-Operative & Dry Dock Company, Oakland, Cal., have asked for a lease from the city of Oakland for the purpose of building a shipyard, floating drydock, machine shop, etc.

The Globe Shipbuilding Company has been organized by B. C. Cooke, Capt. C. A. Massey and M. L. McMahon, Superior, Wis., to build steel freighters for ocean service.

It is reported that Daniel Kern, of the Columbia Transportation Company, Portland, Ore., and John Kiernan, Portland, plan the establishment of a shipyard, and that they have received a contract to build a ship 230 feet long to be equipped with oil engines.

The Pacific Coast Shipbuilding Company has been organized in Tacoma, Wash., with the following officers: J. H. Hyde, president; E. E. Sherwood, vice-president; F. H. Murray, secretary; C. C. Dowd, treasurer, and L. H. Coolidge, naval architect.

The Ryder-Dickman Company, Red Bank, N. J., has been incorporated to operate a boat-building plant. Frank P. and E. W. Dickman, Red Bank, and Harry L. Ryder, South Orange, N. J., are the incorporators.

The Standard Shipbuilding Company, 44 Whitehall street, New York, will build a new plate shop at its plant on Shooters Island.

The Los Angeles Mercantile Marine Company, Black building, Los Angeles, Cal., is planning to lease a site for a shipbuilding plant at San Diego.

The Temple Shipbuilding Company has erected a wooden shipyard at Port Blakeley, Wash., and is understood to have received orders to build several schooners.

The plant of the Holmes Motor Company, Mystic, Conn., has been purchased by Wood & McClure, shipbuilders, City Island, New York.

The Tampa Shipbuilding & Engineering Company, Tampa, Fla., has been organized, with a capital stock of $800,000. Ernest Kreher, of Tampa, is president.

The Mifflin Shipbuilding Company has been incorporated at Dover, Del., with a capital stock of $10,000,000, and plans to build a plant on the Delaware River. The incorporators are A. J. Steelman, C. P. Cannon and C. L. Dambly, all of Philadelphia.

Johnson Porter, of the firm of Porter Bros., Eugene, Ore., is planning the construction of a shipbuilding plant at Florence, Ore.

The New London Ship & Engine Company, Groton, Conn., is making additions to its plant.

The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., is reported to be in the market for a number of punches and shears.

The Standard Shipbuilding Corporation, 44 Whitehall street, New York, has filed plans for a new boiler and plate shop at its plant on Shooter's Island, Staten Island, to cost $250,000.

The Chief of the Bureau of Yards and Docks, Navy Department, Washington, has received proposals for the construction of a one and one-half story machine and electric shop, 150 by 500 feet, at the navy yard, Philadelphia, at a cost of $500,000.

The Sun Shipbuilding Company, Chester, Pa., has had plans prepared for two one-story, brick and concrete additions to its plant. A one-story paint and oil house will also be erected, to be about 35 by 65 feet. The complete plant of the company, which was organized about a year ago (April, 1916), will include 50 acres of land along the Delaware River waterfront. The yard has five steel and concrete shipways.

The Biloxi Shipyard & Box Factory Company, Biloxi, Miss., is reported in the market for about $5,000 worth of equipment. Francis Brander is active in the enterprise.

The plant of the Vickers Company at Montreal is being enlarged by the addition of two covered building berths, which, when finished, will double the shipbuilding accommodation already provided. At present the company has one large berth capable of taking vessels 600 feet long. The dimensions of the new sheds will be 500 feet by 128 feet, and 400 feet by 100 feet, respectively. The sheds will provide for the building of vessels up to approximately 12,000 tons.

The International Navigation Corporation, Wilmington, Del., has been incorporated, with a capital of $1,000,000, to operate shipyards for the construction of boats and ships. William F. O'Keefe, George G. Stiegler and E. E. Wright are the incorporators.

The Murnan Shipbuilding Corporation, Philadelphia, Pa., has been incorporated, with a capital of $3,000,000. John F. Glenn and Samuel J. Ferguson, Philadelphia, and John Davidson, Rutledge, Pa., are the incorporators.

The New York Shipbuilding Company, Camden, N. J., is making extensions in its plant to double the former capacity. Construction has been commenced on four standard freight steamships for company service.

The Temple Shipbuilding Company has been organized and have put up a plant at Port Blakeley, Wash., for the construction of wooden ships.

The Seattle Construction & Dry Dock Company has taken out the sawmill which for so many years was a big part of the plant. This mill was equipped to turn out timbers of almost any size and was once an important part of the yard. Along with the mill went the big power plant, and in their place two new ships' ways have been laid out. A third ships' ways will be built in the slip now occupied by the big steel floating drydock. It is expected that this slip will carry the

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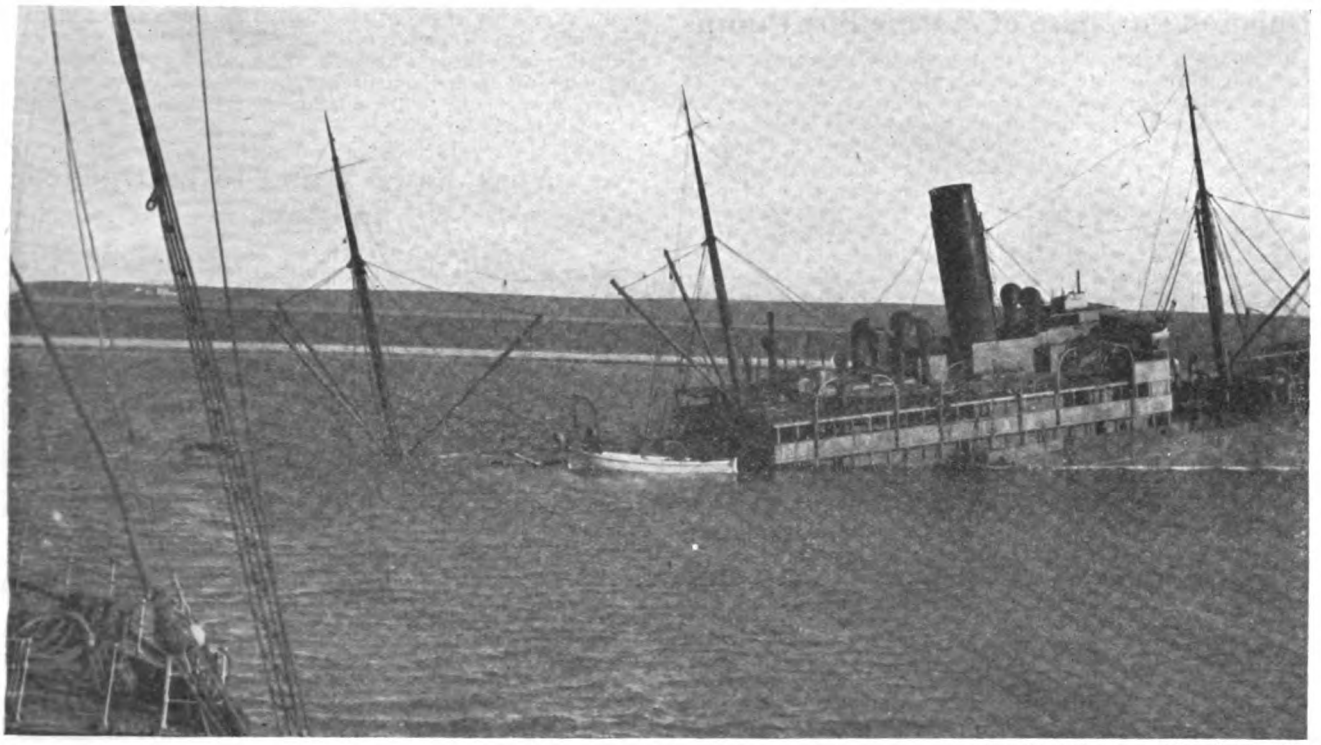

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Ottoman Vessel, Sinking in Salonika Harbor After Bombardment by a Zeppelin Airship

scout cruiser for which plans are now being prepared.

The Ames Shipbuilding & Dry Dock Company has secured a contract for seven steel steamships for the Cunard Steamship Company. This new plant is practically complete, and the keels of the first three of these ships will be laid this month. A fourth ways will probably be built, and on this will be laid down a 9,400-ton oil tanker for the Standard Oil Company. The Ames Company also has a contract for a 9,400-ton freighter for W. C. Peagle, of Cleveland, Ohio.

The United States cruiser *Frederick* is being extensively repaired at the Puget Sound Navy Yard at Bremerton. Repairs include a new fire-directing system, a complete radio outfit and many minor changes. This yard has completed preparations for building the submarine O-2, for which they have the contract and work will be begun at once.

The Ames Shipbuilding & Dry Dock Company let the contract for their machine shop on February 16. This shop will be 420 feet long by 120 feet wide, and is the last unit of the big plant. The mold loft, power house, plate shed, office building, tool house and first building way are completed, and workmen are setting up keel blocks preparatory to the laying of the first keel. The second building way is nearly finished and the third one about half finished.

The Government navy yard at Bremerton has been working on an 11-hour schedule because of the rush of work. It was found that the men could not stand the strain of the extra hours, and the yard has dropped back to the 8-hour day.

Frank Warren, Mayor of Warrenton, Ore., is at the head of a project to raise money for the establishment of a shipbuilding plant in Warrenton.

Marine Terminal Improvements

George S. Webster, Director of Wharves, Docks & Ferries, Philadelphia, Pa., states that an appropriation of $13,300,000 has been ordered for the purchase of property and the erection of modern piers and bulkheads. A contract has already been placed for a pier on the Delaware River at the foot of Cherry street. Plans call for the construction of several new piers on the Delaware River south of Snyder avenue. Piers in other locations will also be built.

The Chamber of Commerce of the City of Columbia, S. C., has recommended that bonds for $50,000 be issued for the purpose of building a wharf and warehouse.

The Board of Control, Toronto, Can., T. McQueen, secretary, is planning to spend about $2,000,000 on a coal dock and storage building.

The Board of State Harbor Commissioners of California has let a contract to the Clinton Construction Company, San Francisco, to build pier 29 at an estimated cost of $104,000.

The Harbor Department, Los Angeles, Cal., has filed plans for the erection of an extensive series of wharves, sheds and warehouses, to cost something like a million dollars.

The City of Providence, R. I., M. H. Bransdon, city engineer, is planning to build five piers at a cost of about $800,000.

In connection with present harbor improvements, the City Commission, Trenton, N. J., has had plans prepared for a terminal dock on the Delaware River near Ferry street. With over 1,000 feet of wharf space available, the proposed work will include the erection of one-story terminal buildings on the north and south sides of the dredged basin, and the construction of open wharves along the upper section of the waterway; the structure on the north side will be provided with a second-story deck for recreation purposes. The municipal buildings will include facilities both for passenger and freight service. For freight operations all necessary labor-saving equipment for handling, storing and loading material will be installed. An initial bond issue of $100,000 has been provided for the inauguration of the work.

The City Commission, Cape May, N. J., has approved plans for the erection of a new pier on the beach front at Howard street. A convention hall will be erected in connection with the structure. The cost of the improvement is estimated at $100,000.

The Seattle Port Commission has called for bids for the construction of a storage annex to their grain elevator, which will increase its capacity from 500,000 to 1,000,000 bushels of grain in bulk. The new unit will consist of thirty storage bins 90 feet high. They will be built of concrete and will cost approximately $87,000.

Passenger Allowance on Vessels

The United States Steamboat Inspection Service has issued a circular letter, dated February 16, 1917, addressed to inspectors of the service and steamboat companies, quoting an act of Congress which was approved February 4, 1917.

The act authorizes supervising inspectors to decrease the number of passengers allowed by local inspectors to be carried on passenger vessels, except ferry boats, and requires the approval of the supervising inspector before the number of passengers allowed on such vessels can be increased. Penalties are provided for the master or owner of any vessel who knowingly allows to be carried a greater number of passengers than is stated in the certificate of inspection.

Before any passenger vessel is allowed to engage in excursions it must be provided with a special permit to carry excursion parties issued by local inspectors, and approved by the supervising inspector of the district.

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Proposed Purchase of Marine Fire Pumps

Following a recent disastrous fire on the Vancouver water front, the business interests of the city have strongly urged the immediate purchase of one or two large fire boats for the better protection against fire of the buildings and wharves along Burrard Inlet. As the purchase of these fire boats is impossible at present, owing to a lack of municipal funds, it has been suggested that temporary fire protection be afforded by the installation of powerful pumps on the ferryboats operating between this city and North Vancouver. It is pointed out that during the hours of operation one of the two ferryboats would always be at or near the Vancouver shore and that during the night arrangements could be made to have one of the boats tied at the Vancouver end of the run. These ferryboats are owned and operated by the municipality of North Vancouver.

Interested dealers in marine fire pumps should communicate with the chief of the Vancouver Fire Departmnt, Vancouver, British Columbia.

Transfer of Ships

According to a report by the Bureau of Navigation, Department of Commerce, between July 1, 1914, and February 28, 1917, ships transferred to the American flag from foreign flags numbered 204 of 664,925 gross tons, and ships transferred from the American to foreign flags numbered 405 of 313,811 gross tons. The American flag made a net gain of 351,114 gross tons and a net loss of 201 vessels; in other words, American citizens bought much larger vessels than they sold.

The bulk of the American gain in tonnage has been from the British and German flags, and the Norwegian, Japanese and French flags have made the largest net gains. The following table shows the foreign flags involved and the number and gross tonnage of vessels transferred from those flags to the American flag and from the American flag to those flags, with the net American increase or decrease:

Flag	To American		From American		American Increase or Decrease	
	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons
Belgian	6	10,519	...	.....	6+	10,519+
British	111	357,669	170	82,651	59—	275,018+
Cuban	6	18,702	37	8,401	31—	10,301+
Danish	5	13,193	5	3,631	....	9,562+
Dutch	6	26,724	3	8,131	3+	18,593+
French	2	6,247	20	26,740	18—	20,493—
German	32	155,941	3	1,603	29+	154,338+
Greek	1	4,471	3	2,119	2—	2,352+
Italian	2	2,769	...	.....	2+	2,769+
Japanese	1	5,869	16	38,720	15—	32,851—
Mexican	9	11,652	35	6,707	26—	4,945+
Norwegian	7	15,311	30	91,211	23—	75,900—
Portuguese	..	.....	7	3,943	7—	3,943—
Roumanian	1	5,275	...	.....	1+	5,275+
Russian	3	2,144	2	986	1+	1,158+
Spanish	..	.....	11	11,963	11—	11,963—
Swedish	..	.....	2	909	2—	909—
South Am. countries	10	23,299	22	18,667	12—	4,632+
Central American, Haitian, Dominican, etc.	2	5,110	39	7,429	37—	2,319—
Total	204	664,925	405	313,811	201—	351,114+

Officers of Engine and Boat Manufacturers' Association Re-Elected

At the March meeting of the executive committee of the National Association of Engine & Boat Manufacturers, held at the Engineers' Club, New York City, the following officers were re-elected for the ensuing year: President, John J. Amory, of the Gas Engine & Power Company and Chas. L. Seabury & Company, Consol., Morris Heights, New York City; first vice-president, Henry R. Sutphen, of The Elco Company, Bayonne, N. J.; second vice-president, Percy C. Jones of the S. M. Jones Company, Toledo, Ohio; third vice-president, Charles A. Criqui, of the Sterling Engine Company, Buffalo, N. Y.; treasurer, James Craig, of the James Craig Engine & Machine Works, Jersey City, N. J.

The report of Mr. Henry R. Sutphen, chairman of the exhibition committee, showed that the 1917 New York National Motor Boat Show, held recently in the Grand Central Palace, was by far the most successful exhibition ever held under the auspices of the association. Substantial increases were made in attendance figures, in amount of space sold to exhibitors and in actual sales made during the progress of the show. Fifty-nine complete boats were on exhibition, ranging in size from the small useful dinghy to the new type, sixty-foot motor patrol boat, with her complete armament of rapid fire guns. A canvass of the prices of all of the boats shown placed the total value of these craft, together with the engines on exhibition, at well over $350,000. The exhibits of accessories, etc., some of the individual units of which were worth over $50,000, brought the total valuation of all exhibits at the show up to a half million dollars.

New York Barge Canal to be Opened in May

The State of New York has announced that daily service on its new barge canal will begin next May. A fleet of eight steamers and twenty-nine consorts will ply between Buffalo and Albany.

These vessels will be operated by a Syracuse company, which was recently incorporated with a capital of $257,500. Another fleet of twenty-two barges will begin operation soon after the canal is opened, and scores of remodeled Erie canal boats, it is stated, will be ready to carry freight as soon as the new State waterway is available for navigation.

It is intended that a regular schedule shall be maintained by the fleets operating in the canal. Calls will be made at all the larger cities including Rochester, Rome, Utica, Little Falls, Fonda, Amsterdam, Schenectady, Troy and Albany. Freight rates on the canal will be about two-thirds the railroad freight charges.

During the season of 1917 only package freight will be carried, but with the development of barge canal craft it is expected that all classes of freight will be received next year.

Recent Launchings

The National Shipbuilding Company launched an 86-foot cannery tender for the Sockey Salmon Company February 26. The new vessel, which will cost $20,000, is 18 feet beam, 7 feet 6 inches deep, and will be powered with a 110-horsepower Standard heavy-duty engine. This company will launch another tender this month, and has just closed a contract with Capt. Wolfe to build a 60-foot steamer for use in Alaska waters.

The submarine *N*-3 was launched from the yard of the Seattle Construction & Dry Dock Company February 22. This is the third of this type of submarine to be launched by this company this spring. The *N*-3 will be in command of Lieut. W. R. Munroe as soon as she is in commission. The *N*-1 and *N*-2 are receiving their finishing touches and will soon be ready for trial trips.

This company launched on March 14 the 7,500-ton freighter *Golden Gate*, building for Knute Knutsen, of Haguesund, Norway. The *Golden Gate* is 396 feet long, 53 feet beam and 29 feet 3 inches deep. Power is furnished by a 2,500-horsepower triple-expansion engine, with cylinders 24 inches, 40 inches, 70 inches by 48 inches stroke and three Scotch marine boilers. She is designed for a sea speed of 11 knots. Her sister ship, the *Key West*, which is building for the same company, will be launched on April 11. A third vessel of the same type will be launched in May.

The Skinner & Eddy Shipbuilding Corporation, Seattle, Wash., launched on March 22 the steel tanker *S. V. Harkness*, which they have been building for the Standard Oil Company, and in April they will launch her sister ship the *Joshua Macey* for the same company. Their next ship off the ways will be the *Stolt-Nielsen*, which will be launched some time in June. This ship is a sister ship to the *Nels Nielsen* and *Louise Nielsen*, already described in MARINE ENGINEERING.

The *Louise Nielsen* underwent her trial trips on March 8, and, although the contract calls for only 11 knots, she made 13½ knots consistently, and on one occasion went over the course at a little better than 14 knots. As this was the first day steam had been turned into her big turbine the record is very good. The *Louise* has been chartered to the Frank Waterhouse Company, and started loading for the Orient on March 10.

Chester Shipyard Reported Sold

Negotiations have been completed for the sale of the Chester Shipbuilding Company, Chester, Pa., to a British syndicate, according to reports from Philadelphia. The purchase price is understood to be $3,000,000, which is estimated as a profit of 200 percent on the original investment. The plans of the new owners are said to include the enlargement of the yard and the construction on an extensive scale of steamers for the transatlantic trade.

The Chester Shipbuilding Company was organized about a year ago to take over the old Roach plant at Chester.

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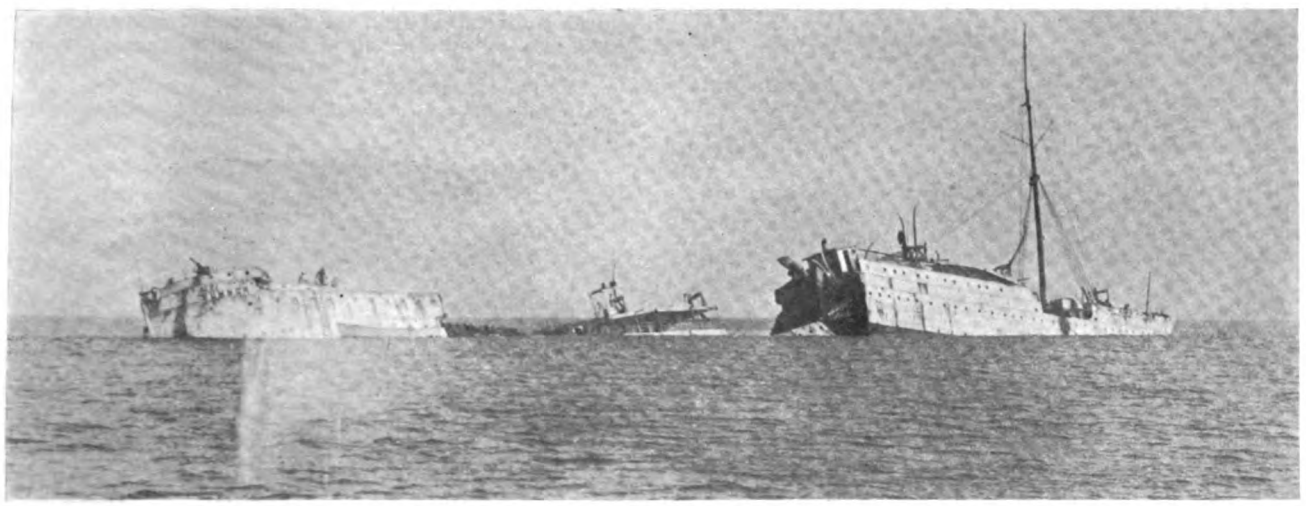


(*Copyright by International Film Service*, 1917)

United States Army Transport *Sumner* Breaking Up Off Barnegat Light, Showing Condition of the Vessel on March 10

Opportunity for Wooden-Ship Building

The Chamber of Commerce of Apalachicola, Fla., solicits correspondence with the builders and owners of wooden vessels, mainly schooners. Timber abounds in the neighborhood.

Nautical School Ship Established by State of Washihgton

The Washington State Legislature, just adjourned, passed a bill authorizing the establishment of a State nautical school ship in Seattle. The Legislature also voted to provide $25,000 a year for the maintenance of the school.

This school comes under the act of Congress establishing seven such schools and appropriating $25,000 a year for each to help maintain the vessels which will be used. The school ship's students will be trained as navigators under the supervision of United States naval officers.

World's Largest Coal Pier Opened

The Baltimore & Ohio Railroad has opened for service its new export coal pier at Curtis Bay, Baltimore, Md., harbor, March 8. The pier, said to be the largest structure of its type in the world, has been in course of construction since February, 1916, and represents an investment of about $3,500,000. It has a capacity of 12,000,000 tons of coal a year, or a maximum of 7,000 tons an hour. Of steel and concrete construction, the structure is equipped for electric operation in all departments, including a system of car unloaders, belts and towers. At maximum operation it is possible to work on four vessels with cargo and bunker coal at the same time.

Record Charter Rates

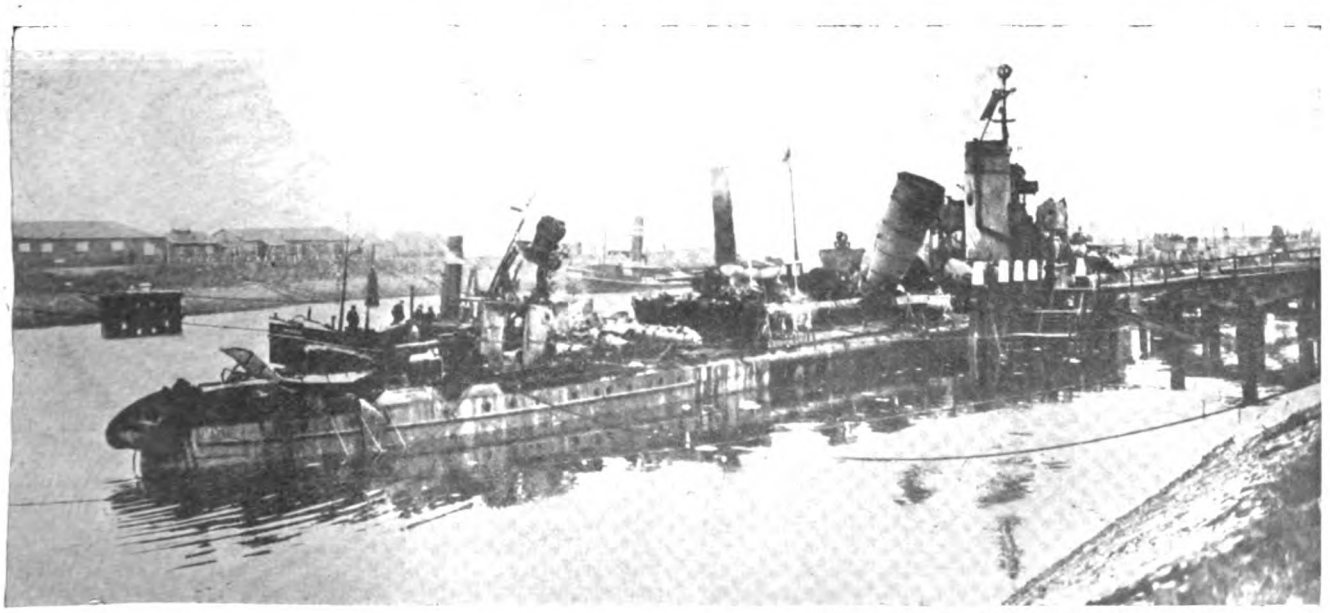
A record in charter rates was established the last week in February when the American-Hawaiian liner *Kentuckian* was chartered to operate between New York and South American ports at a rate of $97,000 per month for twelve months.

High Cost of Steamships

The high cost of steamships was shown on March 6 when the steamship *California*, formerly the *Algoa*, was sold in San Francisco for $1,500,000 by John A. Hooper to New York interests.

This vessel once took the largest consignment of lumber ever taken in one shipment from the Pacific Coast, when she carried 6,500,000 feet from the Columbia River to Sidney. The charter rate for that trip was 6 shillings 9 pence, and the present rate for the same trip is 120 shillings.

The *California* was built in England twenty-one years ago.



(*Photograph from Underwood & Underwood, New York*)

German Destroyer *V*-69 Lying at Anchor in the Harbor of Ymuiden, Holland, near Amsterdam, After Recent Battle with British Naval Forces

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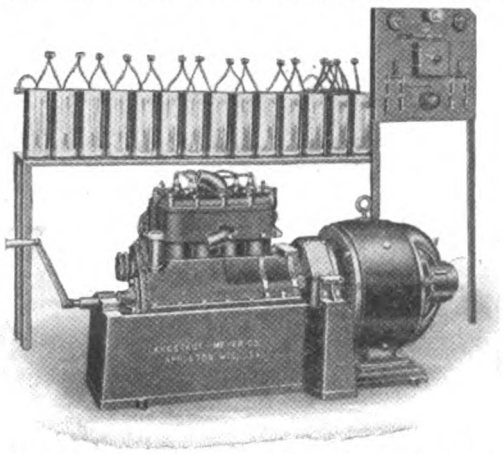
Generating Unit for Marine Use

The illustration shows a gasoline-driven (petrol), direct-connected electric generating unit which is being manufactured by the Langstadt Meyer Company of Appleton, Wis., in two models of 4-kilowatt and 5-kilowatt capacity each, to furnish electric light and power for yachts, vessels, patrol boats and life-saving station service. They are entirely self-contained, quiet and economical in operation and compact. Two of the main features of the design are slow speed, which means long life and low maintenance cost, and a close governor regulation irrespective of the number of lights in operation. The small units will furnish the necessary current for a 19-inch



Gasoline (Petrol)-Driven Electric Generating Unit

8,000-candlepower searchlight suitable for submarine patrol boats or ships, and the larger machine will handle a 24-inch 10,000-candlepower projector.

The portable unit is especially adapted for furnishing current for searchlights used by life-saving stations. The light may be mounted on the shore to aid life-saving crews in the work of shooting lines to the wreck, or in taking men from a stranded vessel. The machine is entirely self-contained, and therefore may be transported on a light truck or hand-drawn vehicle, and may be operated without being removed.

As the operation of these machines, when installed in a boat, is independent of the main engine, all the available power is utilized in the propelling mechanism. Storage batteries are not necessary, but may be installed if desired.

The manufacturers are anxious to get in touch with capable dealers and shipowners needing such equipment. They are ready to furnish detailed description of those units, together with photographs and test data. This information may be obtained by addressing their Appleton office.

D. C. Motors of the Lower Horsepowers

To meet the increasing demand for direct-current motors of the smaller horsepowers for direct connection and drive of all kinds of industrial machinery, machine tools and the many motor applications requiring a low-power, compact motor, the C. & C. Electric & Manufacturing Company, of Garwood, N. J., has developed a new line of type IB bi-polar motors in ratings up to 10 horsepower, in either the shunt or

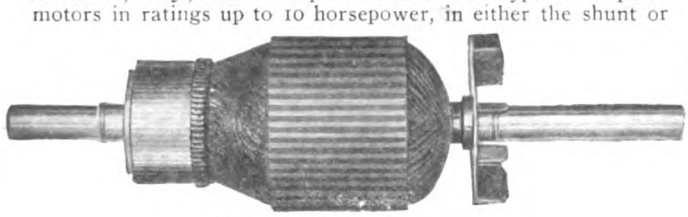


Fig. 1.—The I. B. Armature

compound wound with interpoles. For driving machine tools and other industrial machinery the characteristics of the shunt-wound motors are the most desirable. It is essentially a constant speed machine, having close speed regulation from no load to full load, and is recommended for all purposes where the torque required for starting and accelerating does not greatly exceed full-load torque. The compound-wound motor is desirable for drives where the starting torque is much heavier than the full-load torque. This motor starts at a much heavier load than the shunt-wound motor, and any degree of compounding can be furnished to meet conditions. Adjustment of the speed is obtained in both cases by either armature or field control.

The armatures are of standard design with laminated core.

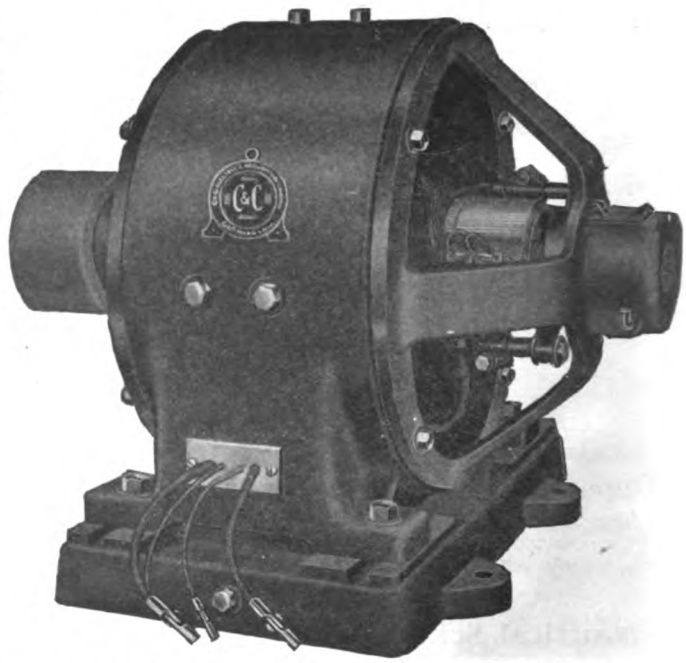


Fig. 2.—C. & C. Type I. B. Motor, with Universal Base

An air agitating fan is placed on the pulley side of the shaft, next to the armature winding, to furnish the very high degree of ventilation and cooling so necessary in motors of the smaller compact frame and guarantees servere service and heavy overloads. In continuous operation for long periods

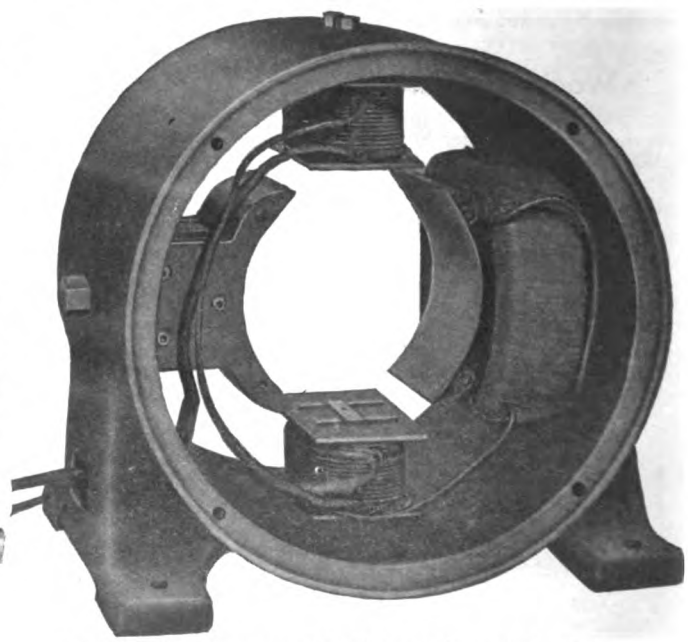


Fig. 3.—Main Frame, with Field and Commutating Poles

the motors run cool and without attention. The interpoles insure sparkless commutation through the full range of load without changing the brush position.

The new line of motors is furnished in the open type, or with perforated or totally enclosing covers for protection against dust, metal chips, dampness, etc. For belt drive the motors can be furnished with either a universal slide rail base or a belt tightener idler pulley.

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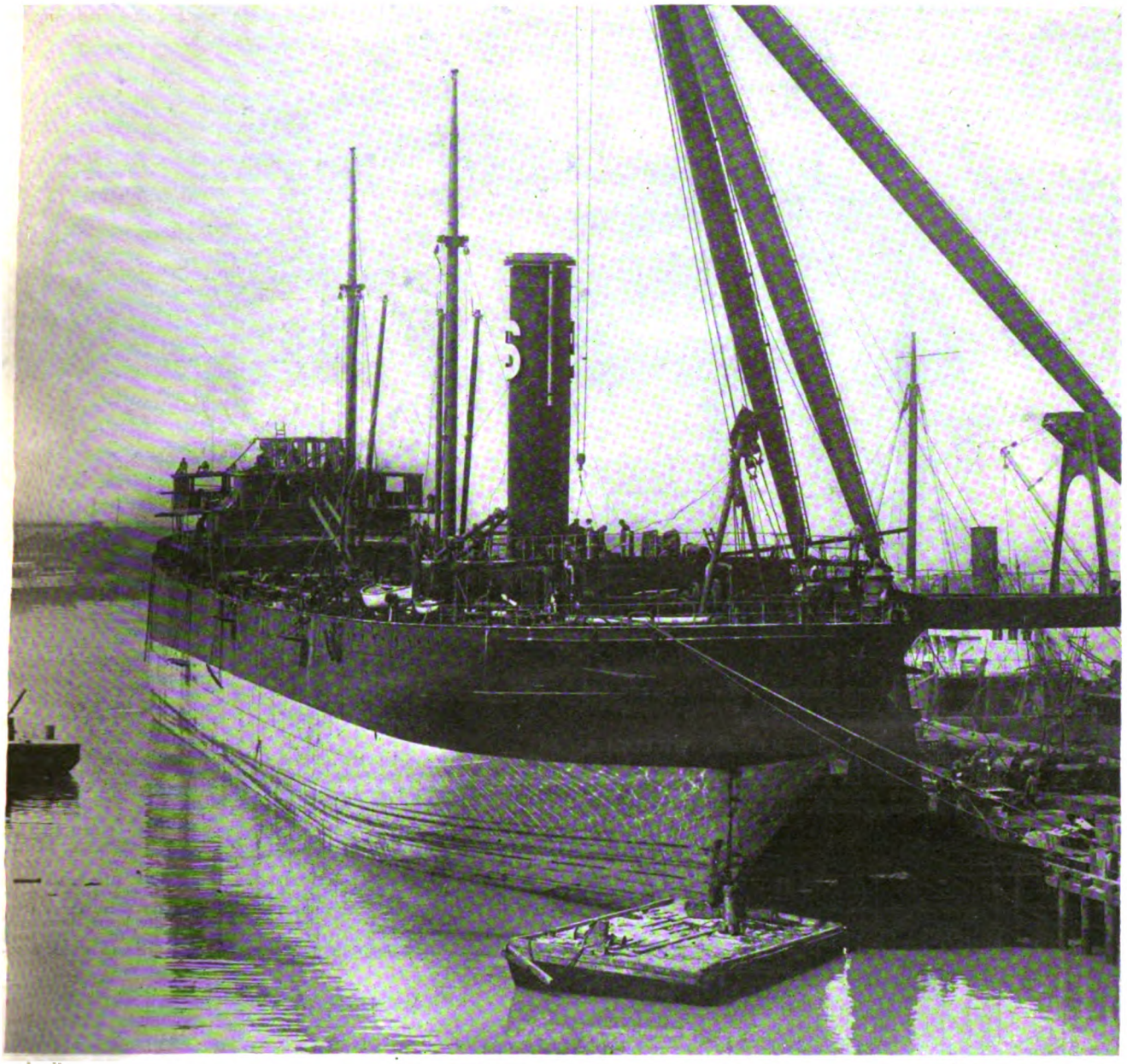

S. S. *D. G. Scofield*, Built in 1916 by the Union Iron Works, San Francisco, for the Standard Oil Company of California, at the Builders' Fitting Out Dock

PERSONAL

H. McL. Harding, terminal engineer, New York city, has been appointed consulting terminal expert in connection with the building of the chain of terminals to be located at the various cities along the New York State barge canal. Mr. Harding is president of the Society of Terminal Engineers recently organized in New York.

Prof. R. C. Carpenter, professor of experimental engineering, Sibley College, Cornell University, will sever his active connection with Cornell University at the end of the present college year, having reached the age of retirement.

B. F. Cresson, Jr., has resigned as chief engineer of the New Jersey State Board of Commerce and Navigation to become consulting engineer, with offices at 30 Church street, New York City. For a number of years Mr. Cresson was first deputy commissioner of the Department of Docks and Ferries of the city of New York. He will specialize in harbor works, piers, docks, bulkheads and reports on harbor improvement.

John C. Payne, of Trenton, N. J., has been appointed chief engineer of the New Jersey Board of Commerce and Navigation, vice B. F. Cresson, Jr., resigned.

Paul P. Whitham, consulting engineer, Seattle, Wash., designer of the municipal piers at Seattle, has been selected by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, to make a study of the existing and proposed port and transportation facilities of Russia and the Far East. Mr. Whitham will be abroad about two years, and his itinerary will include Russia, China, Japan, Philippines, France-China, Federated Malay States, East Indies, Burma, India and Australia.

OBITUARY

John S. Hyde, since 1905 president and sole owner of the Bath Iron Works, Bath, Me., died suddenly on March 17 in St. Augustine, Fla., aged 50 years.

Henderson Weir, secretary of the Harlan & Hollingsworth Corporation, Wilmington, Del., died suddenly on March 4. He had been connected with the company for about twenty-one years.

Capt. George A. White, assistant general manager of the Hudson River Day Line, New York, and well known throughout the country among steamboat men, died in Asheville, N. C., on March 8, aged 61.

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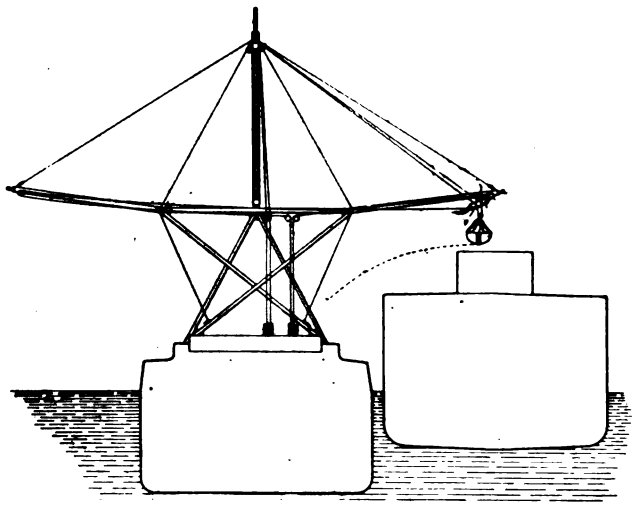
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,193,587. LOAD TRANSFER APPARATUS. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

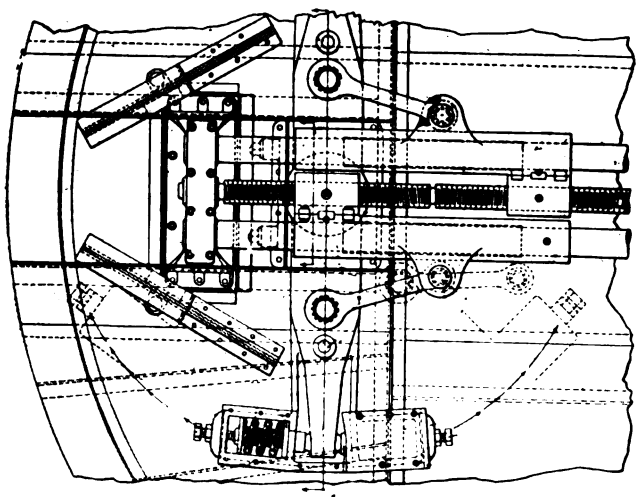
Claim 1.—A load transfer apparaus comprising a mastlike structure, two booms pivotally mounted on said structure, means whereby the



pivots of said booms may be adjusted transversely of said structure, and a rope system supported at its ends by the two booms. Twenty-nine claims.

1,205,169. STEERING APPARATUS FOR SHIPS. WILLIAM A. DOBSON, OF PHILADELPHIA, PA.

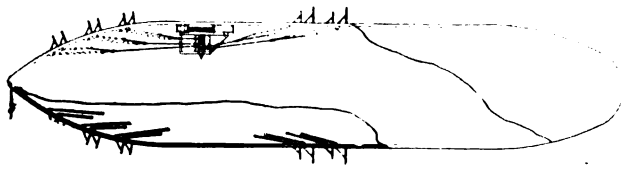
Claim 1.—A steering apparatus for ships, which comprises in combination:—a hull,—a rudder,—a rudder-stock,—a cross-head fixed upon said rudder-stock,—a floating cross-head rotative upon said rudder stock,



—shock-absorbing nechanism interposed between and connective of both cross-heads at their outer extremities,—and steering means for imparting rotative movement to the floating cross-head. Eleven claims.

1,205,638. SHIP-BRAKE. JOHN H. HYDE, OF TACOMA, WASHINGTON.

Claim 4.—The combination with a ship of a plurality of brakes therefor, cables attached to said brakes, and means for hauling in said cables

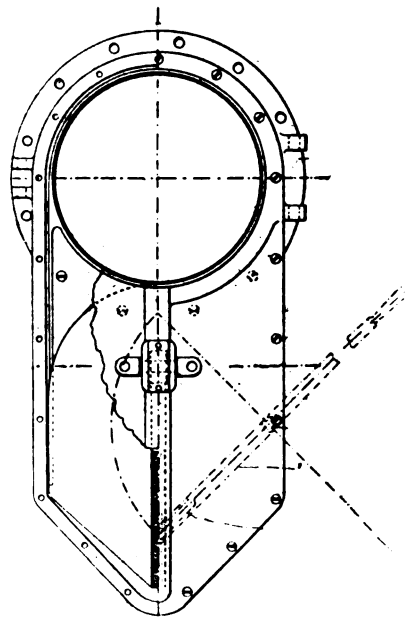


comprising a steam cylinder having a piston therein, an air cylinder, and a piston in said air cylinder connected to said steam piston, said means being so arranged that air is compressed on the outstroke of the brakes whereby the air piston assists the steam piston in drawing in the brakes. Five claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

10,895/15. "IMPROVEMENTS RELATING TO SHIPS' LIGHTS." E. BENVENUTI, OF CAPE DELL UFFICIO TECNICO DELLA NAVIGAZIONE GENERALE ITALIANA, GENOA, ITALY, ENGINEER.

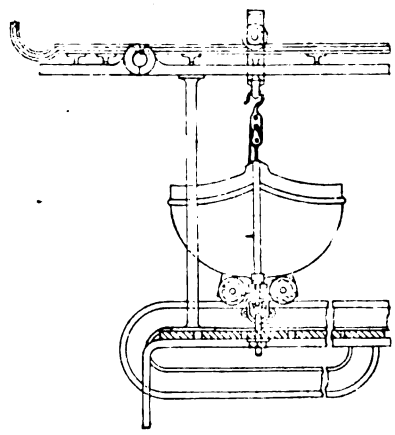
This invention comprises improvements relating to ships' lights, such as port openings and side lights, and it also concerns overboard discharge apertures for ships. The invention has for its object to provide in



addition to the usual lights or sashes, improved means for closing the portholes and other apertures, and also to provide, in some cases, means whereby a number of such closing means may be controlled from a central station, such as the ship's bridge, for example.

11,743/15. MEANS FOR SUPPORTING AND LAUNCHING SHIPS' LIFE BOATS. A. R. HINMAN, OF 9, SIEBERT ROAD, WESTCOMBE PARK, LONDON, S. E.

My invention relates to means for supporting ships' life boats upon movable carriages adapted to travel across the boat deck from side to side, and to means for launching the boat from these carriages from either side of the vessel. To handle and launch life boats, levers are turned so as to release bolts from brackets on each end of the life boat, which is then run along rails until it reaches a position in which it re-



mains suspended from the end of overhead rails, the roller of the bracket engaging in the depression in these end portions of the rail so as to prevent the displacement of the brackets and the suspended life boat, through the rolling of the vessel. The boats, which have been previously manned and nlled when secured in position on the deck, are at once lowered away as rapidly as possible, and as soon as they have reached the water and the tackle has been detached, the brackets are removed from the ends of the overhead rails and are thrown aside. The next boat is then brought up and lowered away in the same manner, and as each boat is run out and launched, the supporting carriages on the rails run over the ends of these rails and down on to the turn-in ends in the compartment underneath the boat deck, in which they will be retained for future use when required. In this manner any desired number of boats may be mounted and supported on the boat deck in a position and manner ready for immediate use without unduly obstructing the deck. These boats may be rapidly filled and launched in succession from either or both sides of the vessel, in accordance with the weather conditions.

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